

CALIFORNIA TRAFFIC CONTROL DEVICES COMMITTEE (CTCDC) AGENDA**March 3, 2016 Meeting (8:30 am to end)****Caltrans District 5****1150 Laurel Ln****San Luis Obispo, CA 93401****Manzanita Conference Room**

The Meeting is open and public/local agencies are invited to attend. For further information regarding this meeting, please contact Chris Engelmann at (916) 653-1816, or email chris.engelmann@dot.ca.gov. Electronic copies of this meeting Agenda and minutes of the previous meetings are available at <http://www.dot.ca.gov/hq/traffops/engineering/ctcdc/index.htm>.

Organization Items

1. Introduction
2. Membership
3. Approval of Minutes of the December 10, 2015 Meeting
4. Public Comments

At this time, members of the public may comment on any item not appearing on the agenda. Matters presented under this item cannot be discussed or acted upon by the Committee at this time. For items appearing on the agenda, the public is invited to make comments at the time the item is considered by the Committee. Any person addressing the Committee will be limited to a maximum of five (5) minutes so that all interested parties have an opportunity to speak. When addressing the Committee, for the record please state your name, address, and business or organization you are representing.

5. Items under Experimentation

- a. Update by SFMTA on Red Pavement Transit Lanes

Agenda Items**6. Public Hearing**

Prior to adopting rules and regulations prescribing uniform standards and specifications for all official traffic control devices placed pursuant to Section 21400 of the California Vehicle Code, the Department of Transportation is required to consult with local agencies and hold public hearings.

Consent Items (minor discussion with vote expected)

<u>Agenda Item</u>	<u>Description</u>	<u>Submitted by:</u>	<u>Lead</u>	<u>Pages</u>
None				

Information Items (New items that may be voted on or brought back as an Action Item in a future meeting)

<u>Agenda Item</u>	<u>Description</u>	<u>Submitted by:</u>	<u>Lead</u>	<u>Page</u>
15-28	Subcommittee report - Legislative inquiry on School Zones	Caltrans	Tong	7
16-01	Hybrid Beacons	Caltrans	Tong	10

<u>Agenda Item</u>	<u>Description</u>	<u>Submitted by:</u>	<u>Lead</u>	<u>Page</u>
16-02	Non-traffic control devices signs Section 1A.08	Caltrans	Tong	13
16-03	ADA Tone/Voice – Ped signal	Caltrans	Tong	14
16-04	Proposal to modify Section 3B.19 on angled parking	Caltrans	Jones	15
16-05	Proposal to modify CA MUTCD and eliminate use of rigid barrier posts on entries to bikeways.	Caltrans	Tong	17

Action Items (Continuing discussion from prior meetings with vote expected)

<u>Agenda Item</u>	<u>Description</u>	<u>Submitted by:</u>	<u>Lead</u>	<u>Page</u>
None	-	-	-	

7. Request for Experimentation

<u>Agenda Item</u>	<u>Description</u>	<u>Submitted by:</u>	<u>Lead</u>	<u>Page</u>
16-06	Request to experiment with bike boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento	City of Sacramento	Jones	18
16-07	Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers	SFMTA	Sallaberry	36
16-08	Request for Permission to Experiment with the Diagonal Down Yellow Arrow Lane Use Control Signal Indications on Freeway	Caltrans District 4	Tong	45
16-09	Request for Permission to Experiment with the Messages and Graphics on Dynamic Message Signs on Freeway	Caltrans District 4	Tong	56
16-10	Request for Permission to use wrong-way retroreflective markers for ramp edgelines and ramp directional arrows Type II, III and V	Caltrans District 11	Tong	70

8. Discussion Items

<u>Agenda Item</u>	<u>Description</u>	<u>Submitted by:</u>	<u>Lead</u>	<u>Page</u>
None				

9. Tabled Items

<u>Agenda Item</u>	<u>Description</u>	<u>Submitted by:</u>	<u>Lead</u>	<u>Page</u>
15-15	Proposal for striping a space for bicycle use at locations with right-turn-only lanes	Caltrans	Tong	78

10. Next Meeting

June 30, 2016

City of San Carlos

11. Adjourn

5. Items under Experimentation

Some reports are available at: <http://www.dot.ca.gov/hq/traffops/engineering/ctcdc/status.htm>

- 09-9 Experiment with Steady Red Stop Line Light (Greenwood)
Status: No update
- 09-21 Experiment with Separated/Protected Bikeway On the Left Side of Two One-Way Streets in the City of Long Beach (Rte 9-112E) (Greenwood)
Status: No Update at this time
- 10-3 Experiment with Second Train Warning Sign “Additional Train May Approach” with a Symbol Sign (Submitted by City of Riverside) (Greenwood)
Status: No Update at this time. See a report on the following website:
<http://www.dot.ca.gov/hq/traffops/engineering/ctcdc/reports/Final%20Report%20Additional%20Train%20May%20Approach%20Sign.pdf>
- 11-3 Experiment with Buffered Bicycle Lanes on 2nd St.between Bayshore & PCH in Naples (Greenwood)
Status: No Update at this time.
- 11-12 Experiment with Circular Rapid Flashing Beacon and RRFB (Greenwood)
Status: No Update at this time.
- 11-13 Experiment with a Sign “RECKLESS DRIVING PROHIBITED” (Winter)
Status: Experiment is on-going and has been extended to collect more data.

Arnel G. Dulay, P.E., T.E.
Head, Traffic Investigations II Section
Traffic and Lighting Division
(626) 300-4748; Dulay, Arnel [ADULAY@dpw.lacounty.gov]
- 11-19 Experiment with 2nd advance California Welcome Center Destination Sign (Tong)
Status: No Update at this time.
- 12-9 Request to Experiment with Yellow LED Border on Pedestrian Signal (Tong)
Status: No new update

The complete report is posted on the following website:
<http://www.dot.ca.gov/hq/traffops/engineering/ctcdc/reports.htm>

Rob Stinger, P.E.
Chief - Traffic Engineering & Operations

Items under Experimentation

Caltrans District 2
530-225-3229

- 12-18 Request to experiment with Red Colored Transit-only Lanes (SF) (Walter)
Status: (1-8-15)
- 12-19 Request to Experiment with Highlighted Shared Lane Markings (LA City) (Bahadori)
Status: No new update.
- 12-21 Request to Experiment with In-Roadway Warning Lights (IRWL) System that would supplement existing traffic signals along the Metro Gold Line (LA Metro) (Winter)
Status: 7-28-15: Here is some background and current status information on the “In-Roadway Warning Lights” (IRWLs).

8(09)-8(E)-Red In-Roadway Lights at LRT Grade Crossings-Los Angeles, CA (Reference# HOTO-1)

The Los Angeles County Metropolitan Transportation Authority (Metro), in cooperation with the City of Los Angeles and the County of Los Angeles, has received permission from the FHWA to conduct a demonstration of an In-Roadway Warning Light (IRWL) system that would supplement existing traffic signal indications at (10) intersections along the Metro Gold Line Eastside Extension and (2) intersections along the Metro Blue Line. This non-standard traffic control system, which is composed of a series of LED lights embedded in the roadway is designed to increase the awareness of the street running light rail trains among motorists approaching the intersection. The IRWLs are intended to supplement (not substitute) the circular red signal indications being shown to the cross-street traffic and the red left turn arrow signal indications being shown to the traffic in the left-turn lanes on the roadway that is parallel to and on both sides of the LRT tracks. The added lights enhance warning indications for motorists when trains approach the intersections, deterring them from making illegal left turns and increasing compliance with red traffic signal indications. The system uses red in-roadway lights that steadily illuminate when LRT traffic is approaching or occupying the crossing.

Installation of the IRWLs at the (12) grade crossings is now complete and the two-year monitoring period began on May 1, 2015. Progress reports will be submitted to the FHWA every 6 months and will include data collected at the trial and control locations. The approved Evaluation Plan analyzes traffic violations observed by photo enforcement and in-field observation. Collected data will be summarized and compared to data collected prior to the IRWL installation. A final report will be developed once the monitoring period is complete on April 30, 2017.

For more information, please contact Lia Yim, YimB@metro.net

- 12-25 Request for permission to experiment with various Bicycle Treatments (Winter)
(Santa Monica)
Status: No new update.

Items under Experimentation

- 13-01 Request to Experiment with Green & Shared Roadway Bicycle Markings – Proposed by the City of Oakland (Patterson)
[Status: No new update](#)

Jason Patton, PhD**Bicycle & Pedestrian Program Manager**

Transportation Planning & Funding Division

Department of Engineering & Construction

City of Oakland | Public Works Agency | APWA Accredited Agency

250 Frank H. Ogawa Plaza, Suite 4344 | Oakland, CA 94612

(510) 238-7049 | (510) 238-7415 Faxjpatton@oaklandnet.com

- 13-02 Request to Experiment with Bike Boxes and Wide Bike Strip Stripe (Walter)
-Proposed by the City of Davis
[Status: \(12/1/2014\) City of Davis installed experimental bike boxes in September 2014. Experimentation is ongoing.](#)
- 15-12 Evaluation of Traffic Calming in Treatments in Princeton, CA (Hallaberry)

[Status: \(1/28/16\) Speeds are currently being evaluated and that results will be shared at a future meeting.](#)

[Scott M. Lanphier, PE, CFM](#)[Director of Public Works+](#)[1215 Market Street](#)[Colusa, CA 95932](#)[530-458-0466 \(p\)](#)[530-458-2035 \(f\)](#)slanphier@countyofcolusa.orgwww.countyofcolusa.org

6. Public Hearing**Consent Items (New items that are voted on with minimal discussion)**

None

Information Items (New items that may be voted on or brought back as an Action Item in a future meeting)**Item 15-28 Subcommittee report on School Zones**

Recommendation: A CTCDC subcommittee will report on findings related to existing language in the California Vehicle Code (CVC) related to school zones and school zone speed limits. An action vote is expected at the June CTCDC meeting.

Agency Making Request/Sponsor: Caltrans/ Duper Tong, voting member

Background

The Senate Committee on Transportation and Housing requested the CTCDC to review and examine current language in the CVC regarding school zones and school speed limits and report back in 2016. A CTCDC subcommittee was formed in December 2015 to examine these topics and consider if there is a need to revise the language.

VICE CHAIRMAN
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California Legislature

SENATE COMMITTEE ON TRANSPORTATION AND HOUSING

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September 10, 2015

Hamid Bahadori, Chair
California Traffic Control Devices Committee
Automobile Club of Southern California
3333 Fairview Road
Costa Mesa, CA 92626

Dear Mr. Bahadori:

Senator Cannella introduced legislation this year, SB 632, which would:

- Authorize a local authority to establish a prima facie speed limit of 15 mph or 25 mph in a residence district, on a highway with a posted speed limit of 30 mph or slower, within 1,320 feet of a school building or school grounds that are contiguous to a highway or school grounds that are not separated from the highway by a fence, gate, or other physical barrier;
- Authorize a local authority, upon the basis of an engineering and travel survey documenting school attendance boundaries and/or travel patterns to and from a school, to extend the maximum distance to establish a prima facie speed limit and school warning signs to a distance and/or specific locations that are consistent with the survey findings; and
- Remove the “when children are present” standard and authorize a local authority to designate these low-speed school zones to be in effect according to alternative methodologies, up to 24 hours a day.

Committee members and staff have engaged in discussion over this bill and it has become clear to us that this legislation raises engineering issues that are beyond the expertise of this committee. Specifically, should a school zone extend to one-quarter mile, or more, beyond a school? Should “when children are present” be replaced by another standard?

Given the engineering questions raised by SB 632, members of the Senate Transportation and Housing Committee feel that it is appropriate to refer these questions to the California Traffic Control Devices Committee (CTCDC) for review. We urge the CTCDC and its associated experts to seriously examine these issues. We also urge the CTCDC to report to the Senate Transportation and Housing Committee, in writing, by April 1, 2016, as to its findings on these issues and any further actions, if any, that the CTCDC plans to take or recommends that the Legislature take.

Thank you for your consideration and response.

Sincerely,


SENATOR JIM BEALL
Chair


SENATOR ANTHONY CANNELLA
Vice Chair

cc: Members, Senate Transportation and Housing Committee
Malcolm Dougherty, Director, California Department of Transportation

Item 16-01 Hybrid Beacons

Recommendation: Provide a recommendation on language in the CA MUTCD to promote the use of Hybrid Beacons within 100' of an intersection, yet maintain the text as guidance. An action vote is expected at the June or later CTCDC meeting.

Agency Making Request/Sponsor: Caltrans/ Duper Tong, voting member

Background:

Current guidance in the CA MUTCD recommends the use of pedestrian activated hybrid beacons should be at least 100' from an intersection with a side street or major driveway.

The Signals Technical Committee (STC) feels that the use of pedestrian hybrid beacons at intersections or driveways has been adequately evaluated and operational problems associated with being installed at such locations have not been experienced. Therefore, the STC recommended that the National Committee recommends to FHWA that the guidance for installing a pedestrian hybrid beacon at least 100 feet from an intersection or driveway be deleted and that related text regarding installation at an intersection or driveway be added.

Most locations included in hybrid beacon studies were at or near a side street or major driveway intersections.

Proposal:

Consider changes to language in the CA MUTCD that does not compromise substantial conformance with the 2009 federal MUTCD, yet provides practitioners flexibility and support in their decision to use a hybrid beacon within 100' of a side street or major driveway intersection.

ATTACHMENT No. 14 Signals-1

Approved by National Committee Council



National Committee on Uniform Traffic Control Devices

17200 West Bell Road No. 1135 * Surprise, Ariz. 85374
Telephone (623) 214-2403 * e-mail: ncutcd@aol.com

The Signals Technical Committee distributed a technical committee recommendation to sponsors concerning pedestrian hybrid beacons following the January 2011 meeting. Sponsor comments were reviewed and discussed at the June 2011 meeting. Based on the sponsor comments, minor wording changes were made by the STC and presented to the National Committee Council at the June 23, 2011 meeting. The recommended changes to the MUTCD, as modified by the STC at the June meeting, were approved by the National Committee Council.

The recommended changes to the text of Section 4F.02 approved by the National Committee Council are shown below with existing MUTCD text to be deleted shown in ~~red strikethrough~~ and new text to be added shown in underline blue.)

Section 4F.02 Design of Pedestrian Hybrid Beacons

Standard:

- 01 Except as otherwise provided in this Section, a pedestrian hybrid beacon shall meet the provisions of Chapters 4D and 4E.
- 02 A pedestrian hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications (see Figure 4F-3).
- 03 When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:
 - A. At least two pedestrian hybrid beacon faces shall be installed for each approach of the major street,
 - B. A stop line shall be installed for each approach to the crosswalk,
 - C. A pedestrian signal head conforming to the provisions set forth in Chapter 4E shall be installed at each end of the marked crosswalk, and
 - D. The pedestrian hybrid beacon shall be pedestrian actuated.
 - E. If a pedestrian hybrid beacon is installed at or immediately adjacent to an intersection with a side road, vehicular traffic on the side road shall be controlled by STOP signs.

Guidance:

- 04 When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:
 - ~~A. The pedestrian hybrid beacon should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs;~~
 - AB. Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk, or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance,
 - ~~BC. The installation should include suitable standard signs and pavement markings, and~~
 - ~~CD. If installed within a signal system, the pedestrian hybrid beacon should be coordinated.~~

- 05 *On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 35 mph and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside hybrid beacon face locations, both of the minimum of two pedestrian hybrid beacon faces should be installed over the roadway.*
- 06 *On multi-lane approaches having a posted or statutory speed limits or 85th-percentile speeds of 35 mph or less, either a pedestrian hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the pedestrian hybrid beacon faces should be installed over the roadway.*
- 07 *A pedestrian hybrid beacon should comply with the signal face location provisions described in Sections 4D.11 through 4D.16.*
Standard:
- 08 **A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign (see Section 2B.53) shall be mounted adjacent to a pedestrian hybrid beacon face on each major street approach. If an overhead pedestrian hybrid beacon face is provided, the sign shall be mounted adjacent to the overhead signal face.**
Option:
- 09 **A Pedestrian (W11-2) warning sign (see Section 2C.50) with an AHEAD (W16-9P) supplemental plaque may be placed in advance of a pedestrian hybrid beacon. A warning beacon may be installed to supplement the W11-2 sign.**
Guidance:
- 10 *If a warning beacon supplements a W11-2 sign in advance of a pedestrian hybrid beacon, it should be programmed to flash only when the pedestrian hybrid beacon is not in the dark mode.*
Standard:
- 11 **If a warning beacon is installed to supplement the W11-2 sign, the design and location of the warning beacon shall comply with the provisions of Sections 4L.01 and 4L.03.**

For reference, the item as distributed to sponsors and including the reason for proposed changes is on the following pages. The changes made by the STC at the June meeting were the deletion of “or driveway” in two places in proposed new item E in paragraph 03 as shown:

E. If a pedestrian hybrid beacon is installed at or immediately adjacent to an intersection with a side road ~~or driveway~~, vehicular traffic on the side road ~~or driveway~~ shall be controlled by STOP signs.

From Kevin Korth, FHWA:
Chris,

I am ok with considering the addition to paragraph 3 using the term “side street” instead of “side road” from the NCUTCD recommendation to be consistent with existing terminology in paragraph 04.

I do not support the change of the guidance in paragraph 04 unless the CTCDC and Caltrans can satisfactorily explain based on engineering judgment, specific conflicting State law, or a documented engineering study the reason for the change per 23 CFR 655.603(b).

Kevin Korth, EIT
Traffic Operations Engineer
FHWA CA-Division

Item 16-02 Proposal to modify CA MUTCD Section 1A.08 on Non Standard Traffic Control Devices - Signs

Recommendation: Provide a recommendation on whether or not to modify the CA MUTCD to restrict non-standard signs on roadways. Provide a recommendation on changes to the language in the CA MUTCD as needed. An action vote is expected at the June CTCDC meeting.

Agency Making Request/Sponsor: Caltrans/ Duper Tong, voting member

Background

Nonstandard signs are being requested statewide, resulting in inconsistent responses in permitting or prohibiting their use. The intent of this proposal is to create uniformity among the types of requests approved for non-standard signs.

Proposal

Only signs that meet any of the following criteria may be permitted on public roadways:

- Governor's or Presidential Executive Order (e.g., "USING RECYCLED WATER" sign, related to drought)
- Legislative request (Senate- or Assembly Concurrent Resolution [SCR, or ACR])
- FHWA allowances, such as construction project funding signs
- Traffic Safety Campaigns (e.g. "CLICK IT OR TICKET" signs)

Item 16-03 Proposal to modify Section 4E.11

Recommendation: Make a recommendation on whether or not to change Section 4E-11 to address tone vs audible message with accessible pedestrian signals.

Agency Making Request/Sponsor: Caltrans/ Duper Tong, voting member

Background

The HQ Traffic Operations, Electrical System Branch 's interpretation of the CAMUTCD language for the message that it applies to the corner of the Intersection, and the audible message will be the same for all corners of the same intersection.

Based on a meeting with the Caltrans ADA office, and based on feedback from The California Council of the Blind (CCB), and the pedestrians with mobility impairment ' training consultants, the interpretation and the recommendation of the "audible message" and the separating distance applies to each individual corner of the intersection, and it could be a different outgoing message within the same intersection, or the same crossing, based on the separating distance between the two accessible pedestrians signals.

Current language in the CA MUTCD Section 4E.11 reads as follows:

Standard:

⁰⁷ Where two accessible pedestrian signals are separated by a distance of at least 10 feet, the audible walk indication shall be a percussive tone. Where two accessible pedestrian signals on one corner are not separated by a distance of at least 10 feet, the audible walk indication shall be a speech walk message.

Proposal:

The audible message will apply to the intersection, keeping the same message for each pedestrian crossing the same for each phase.

Proposed changes are as follows:

Standard:

⁰⁷ Where two accessible pedestrian signals are separated by a distance of at least 10 feet **on a corner of the intersection**, the audible walk indication shall be a percussive tone **on that corner only**. Where two accessible pedestrian signals on ~~one~~ a corner are not separated by a distance of at least 10 feet, the audible walk indication shall be a speech walk message **for that corner only**.

Item 16-04 Proposal to modify Section 3B.19 on Angled Parking

Recommendation: Provide a recommendation on how to modify the CA MUTCD to permit angled parking. An action vote is expected at the June CTCDC meeting.

Agency Making Request/Sponsor: Caltrans/ Bryan Jones, Active Transportation Voting Member

Background

The CA MUTCD specifies that diagonal parking stalls are not permitted on State highways. This policy has carried over from the Traffic Manual and is based on studies done on angled parking in the early '90s. These studies indicate that angled parking has higher collision rates than parallel parking. Currently the California Vehicle Code permits angled parking on streets and highways, including State highways when approved by Caltrans.

Since the 1990's, Caltrans goals and missions have changed. The guide, Main Street, California, A Guide for Improving Community and Transportation Vitality encourages the use of diagonal parking. In addition, Caltrans has been highlighting their success with Bridgeport where diagonal parking was used on a State facility. As noted, there may be locations where diagonal parking can be part of a "complete streets" solution.

The CA MUTCD currently reads:

Policy on Parking Restrictions**Option:**

07 Local authorities may, by ordinance, provide for the establishment of parking meter zones and cause streets and highways to be marked with white lines designating parking spaces. Refer to CVC Section 22508.

Standard:

08 Where the proposed zones are on State highways, the ordinances shall be approved by Caltrans.

09 Local authorities shall furnish a sketch or map showing the definite location of all parking meter stalls on State highways before Caltrans approval is given.

Support:

10 The District Directors have been delegated the authority to approve such ordinances.

11 The desirable dimensions of parking meter stalls are 8 feet by 24 feet with a minimum length of 20 feet.

Guidance:

12 At all intersections, one stall length on each side measured from the crosswalk or end of curb return should have parking prohibited. A clearance of 6 feet measured from the curb return should be provided at alleys and driveways.

13 At signalized intersections parking should be prohibited for a minimum of 30 feet on the near side and one stall length on the far side. See Figure 3B-21(CA).

Standard:

14 The departmental approval for the installation of the parking meters shall be covered by an encroachment permit.

Option:

15 Local authorities may by ordinance permit angle parking. Refer to CVC 22503.

Support:

16 Caltrans does not approve ordinances establishing angle parking on State highways.

17 Diagonal parking stalls are not permitted on State highways.

Item 16-04 Proposal to modify Section 3B.19 on Angled Parking

The California Vehicle Code reads as follows:

Local Ordinance: Angle Parking

22503. Local authorities may by ordinance permit angle parking on any roadway, or left-hand parking upon one-way roadways of divided highways, except that no ordinance is effective with respect to any state highway until the proposed ordinance has been submitted to and approved in writing by the Department of Transportation.

Amended Ch. 545, Stats. 1974. Effective January 1, 1975.

Proposal

Modify the 2014 CA MUTCD 3B.19 paragraph 16 and 17 to be in alignment with language from Main Street, California A Guide for Improving Community and Transportation Vitality page 57 regarding Motor Vehicle Parking that encourages the use of diagonal parking. In addition, Caltrans has been highlighting their success with Bridgeport where diagonal parking was used on a state facility.

Caltrans District Traffic Safety Engineers have been consulted and most would support diagonal parking on State highways with only the following conditions:

- Back-in angled parking only
- Low vehicle volumes
- Sufficient width to provide stopping sight distance, may include a bikelane.
- Low vehicle speeds, 25 mph or less
- Provide ADA accessible parking that may require traditional parking configurations

Item 16-05 Proposal to modify CA MUTCD and eliminate use of rigid barrier posts on entries to bikeways.

Recommendation: Request the committee to make a recommendation on whether to modify text in the CA MUTCD to eliminate use of bollards or barrier posts on bikeway entry points. An action vote is expected at the June CTCDC meeting.

Agency Making Request/Sponsor: Caltrans/ Duper Tong, voting member

Background:

The California Bicycle Advisory Committee requested that the CA MUTCD indicate that entries to bikeways to not include the use of bollards or barrier posts to prevent entry of motor vehicles onto a bikeway.

The CA MUTCD currently reads:

Section 9C.101(CA) Barrier Posts on Class I Bikeways**Support:**

01 Before a decision is made to install barrier posts, consideration needs to be given to the implementation of other remedial measures, such as Bike Path Exclusion (R44A(CA)) signs (see Section 9B.08) and/or redesigning the path entry so that motorists do not confuse it with vehicle access.

02 It could be necessary to install barrier posts at entrances to bike paths to prevent motor vehicles from entering. When locating such installations, care needs to be taken to assure that barriers are well marked and visible to bicyclists, day or night (i.e., install reflectors or reflectorized tape).

Guidance:

03 *An envelope around the barriers should be striped as shown in Figure 9C-8. If sight distance is limited, special advance warning signs or painted pavement warnings should be provided. Where more than one post is necessary, 5 foot spacing should be used to permit passage of bicycle-towed trailers, adult tricycles, and to assure adequate room for safe bicycle passage without dismounting. Barrier post installations should be designed so they are removable to permit entrance by emergency and service vehicles.*

Support:

04 Generally, barrier configurations that preclude entry by motorcycles present safety and convenience problems for bicyclists.

Guidance:

05 *Such devices should be used only where extreme problems are encountered.*

Proposal:

Proposals could include use of flexible barriers instead of a fixed barrier post.

Item 16-05 Proposal to modify CA MUTCD and eliminate use of rigid barrier posts on entries to bikeways.

Action Items (Continuing discussion from prior meetings with vote expected)

None

7. Requests for Experimentation**Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento**

Recommendation: Request to authorize to conduct experiment bike boxes and two-stage left-turn queue boxes in the City of Sacramento.

Agency Making Request/Sponsor: City of Sacramento/ Bryan Jones, Caltrans Active Transportation, voting member

Background: Both H and J Streets are important east-west travel corridors that link East Sacramento and Downtown Sacramento to the H Street Bridge over the American River and further to destinations in Sacramento County to the east. Carlson Drive is an important corridor that provides connection to the south to Sacramento State University and access to the north to River Park, a community for approximately 5,000 residents. These intersections experience a significant amount of vehicular, bicycle and pedestrian traffic. The current configurations to these intersections have largely been oriented to motor vehicle users. The improvements proposed with this project are aimed at improving access for bicyclists and pedestrians who travel through these intersections. Both the Carlson/H and Carlson/J intersections are large, complex and different from each other. As such, they present challenges to bicyclists who are attempting to navigate them. Several bicycle infrastructure items are being proposed to be installed. The emphasis for this application is aimed at improving the ability for bicyclists to make left turns in these intersections. While “vehicular style” left turns can be accomplished with the current configuration, the high levels of traffic and the greater than average number of bicyclists in the area suggest that more options be provided.

Executive Summary:

The City of Sacramento requests permission to establish an experimental installation of bike boxes and two-stage left-turn queue boxes at H Street/Carlson Drive and J Street/Carlson Drive in Sacramento, CA. This application is prepared in compliance with Section 1A.10 of the Manual on Uniform Traffic Control Devices (MUTCD) and the California Manual on Uniform Traffic Control Devices (CA-MUTCD).

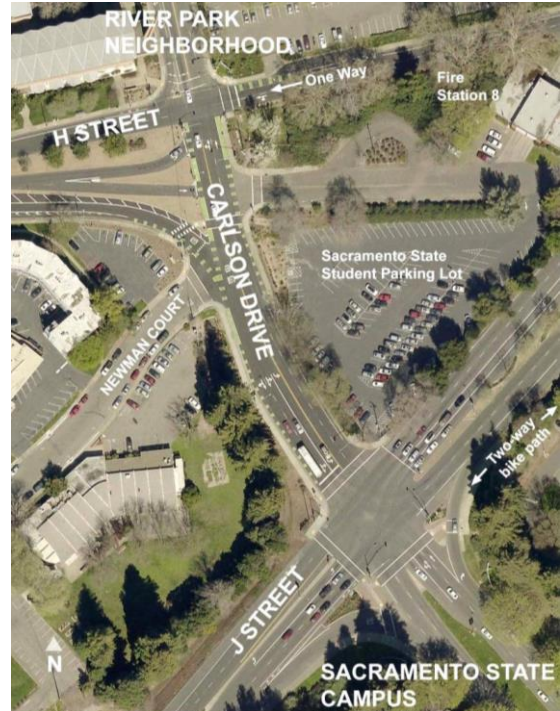
Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

Background

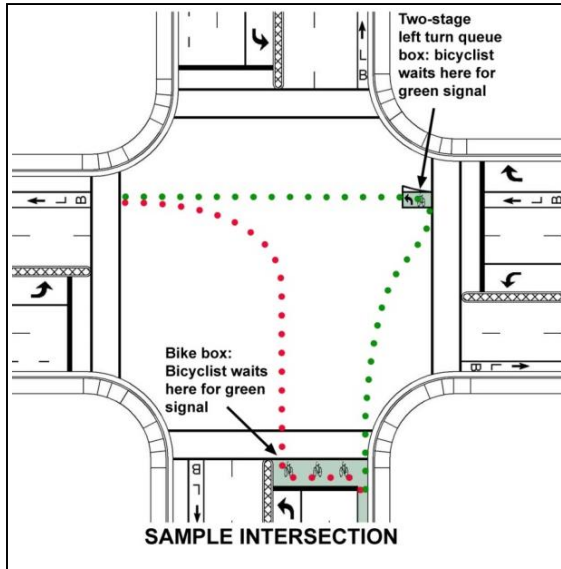
Both H and J Streets are important east-west travel corridors that link East Sacramento and Downtown Sacramento to the H Street Bridge over the American River and further to destinations in Sacramento County to the east. Carlson Drive is an important corridor that provides connection to the south to Sacramento State University and access to the north to River Park, a community for approximately 5,000 residents.

These intersections experience a significant amount of vehicular, bicycle and pedestrian traffic. The current configurations to these intersections have largely been oriented to motor vehicle users. The improvements proposed with this project are aimed at improving access for bicyclists and pedestrians who travel through these intersections.

Both the Carlson/H and Carlson/J intersections are large, complex and different from each other. As such, they present challenges to bicyclists who are attempting to navigate them. Several bicycle infrastructure items are being proposed to be installed. The emphasis for this application is aimed at improving the ability for bicyclists to make left turns in these intersections. While “vehicular style” left turns can be accomplished with the current configuration, the high levels of traffic and the greater than average number of bicyclists in the area suggest that more options be provided.

*Design Concept*

Traffic control devices that are proposed are the “bike box” and the “two-stage left-turn queue box.” Both devices provide refuge waiting areas for bicyclists who wish to make a left turn at an intersection.



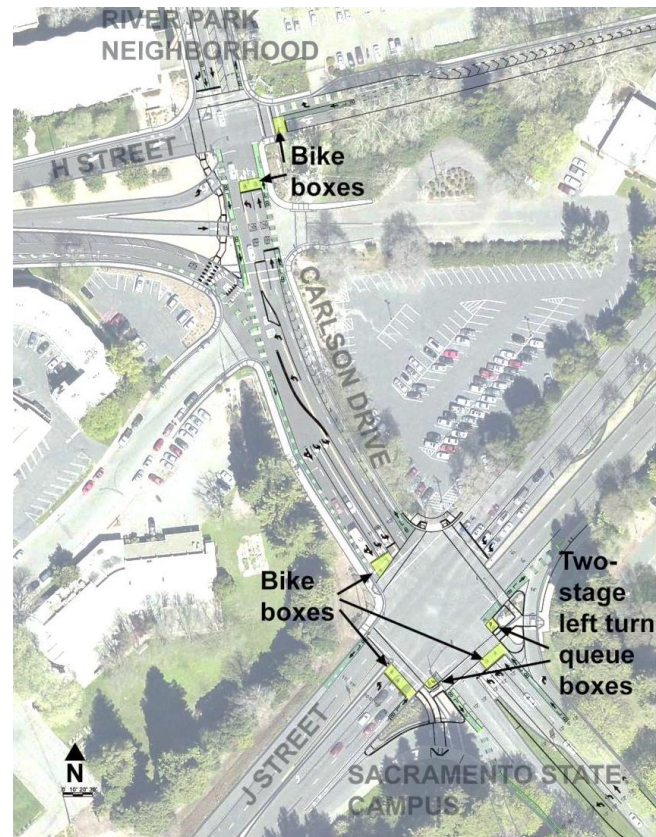
When the traffic signal for the approach leg is red, the bicyclist enters the bike box from the right and then moves laterally to the left to be positioned in front of the left turn lane. When the traffic signal changes to green, the bicyclist then enters the intersection and completes the left turn (see red dotted path).

When the traffic signal for the approach leg is green, the bicyclist enters the intersection on the right side and then moves laterally to the right to be positioned in the two-stage left-turn queue box that aligns with the crossing traffic. The bicyclist waits in the box for a green light, then crosses the intersection to complete the equivalent left turn movement (see green dotted path).

Proposal:

Bike boxes by themselves are useful to bicyclists who are approaching the intersection and the traffic signal is red and vehicles are stopped. Two-stage left-turn queue boxes are useful to bicyclists who are approaching the intersection and the traffic signal is green and vehicles are moving. There is significant traffic on H Street, J Street and Carlson Drive at all times. This means that there will be an equal chance that a bicyclist approaching the intersection will encounter either stopped or moving vehicles. The proposed project will use both bike boxes and two-stage left-turn queue boxes to accommodate these different conditions. Bike boxes are proposed at both intersections. Two-stage left-turn queue boxes are proposed only at Carlson/J.

End of Executive Summary



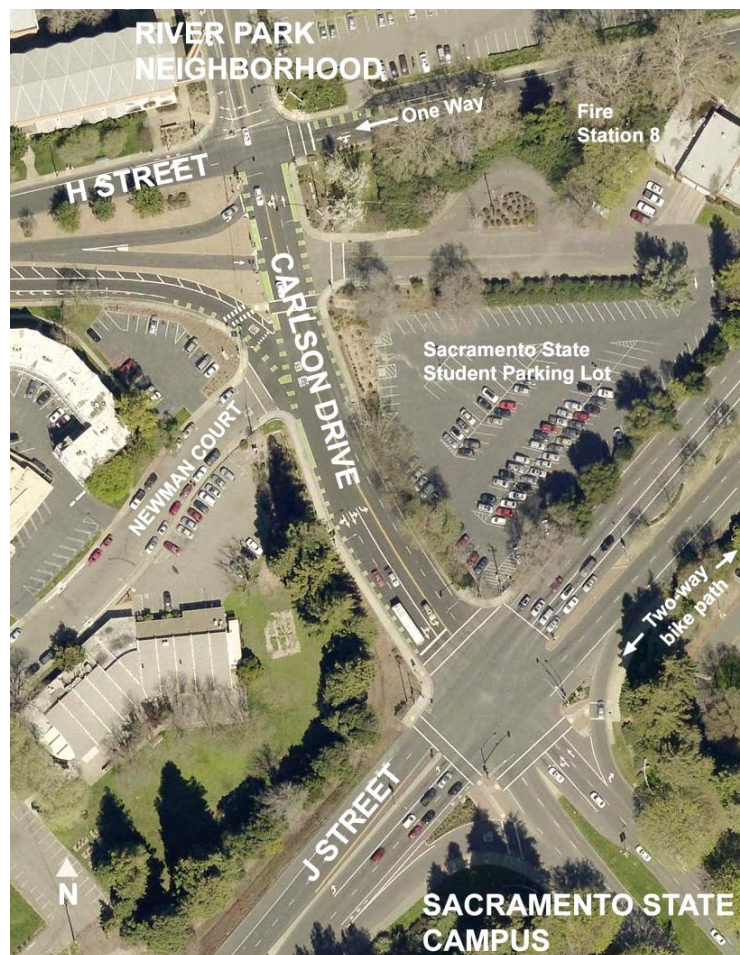
Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

Setting:

The proposed project location is on Carlson Drive where it intersects with both H Street and J Street. All three streets are important thoroughfares connecting key destinations. Carlson Drive is an important corridor that provides connection to the south to Sacramento State University and access to the north to River Park, a community for approximately 5,000 residents. H and J Streets are important east-west travel corridors that link East Sacramento and Downtown Sacramento to the H Street Bridge over the American River and further to destinations in Sacramento County to the east.

At the Carlson/H intersection, Carlson Drive has north-south traffic and H Street has east-west traffic. Its unconventional configuration is primarily a result of two-way traffic on the west leg and one-way, westbound traffic on the east leg. Most of the eastbound traffic on H Street turns right or left onto Carlson Drive, where the heaviest movement is the right turn onto southbound Carlson Drive. A very small amount of eastbound traffic crosses Carlson Drive to access a student parking lot and Fire Station 8. The westbound approach for H Street is a portion of the traffic that originates from the bridge over the American River. The other portion from the bridge splits and becomes westbound J Street.

The intersection of Carlson/J is more conventional, where J Street has east-west traffic the majority of it is the through movement. Left turns, especially west to south and south to east are heavy movements. Right turns entering and exiting the Sacramento State campus have channelizing islands.



Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

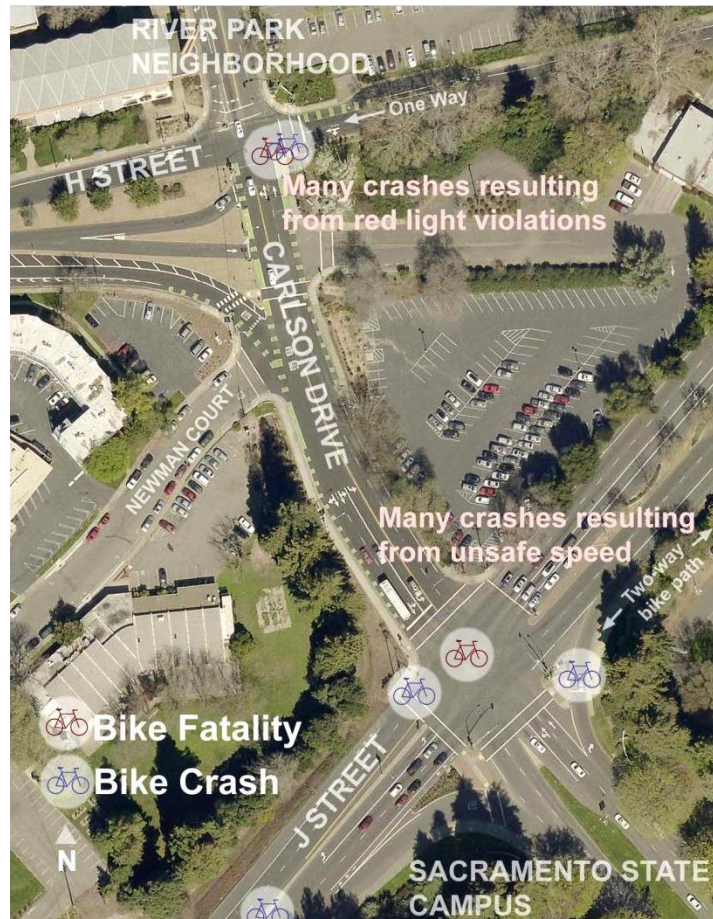
Bike lanes occur on Carlson Drive, H Street and J Street. The east leg of J Street in the westbound direction does not have a marked bike lane. Alternatively, the westbound bicycle traffic in this location uses the separate two-way bike path that is adjacent to the south side of J Street east of Carlson Drive. This path connects to the American River Bike Trail and parts of the Sacramento State Campus. To introduce bicycle friendly features, the City recently upgraded the bike lanes and colored them green.

Crash History:

Both intersections have been the scene for low to moderate numbers of crashes. During the five years between 2010 to the end of 2014, there have been 31 recorded crashes on Carlson between H and J Streets (a detailed table and summary is in the attached appendix). The most common crash occurred where westbound H Street approaches the intersection with Carlson Drive. Vehicles would broadside each other, typically resulting in property damage and/or complaint of pain. Violation of traffic signs and signals were the most common cause of crashes at this location. Another frequent cause for crashes was from vehicles travelling at an unsafe speed at both Carlson/H and Carlson/J. No records of pedestrian involved crashes were found. Crashes involving bicycles occurred six times in the area.

The six individual bicycle crash reports indicated two at Carlson/H, three at Carlson/J and one about 900 feet west of Carlson/J. At Carlson/H both crashes occurred when the bicyclists were northbound and reportedly ran through the red light. One of these resulted in the bicyclist being killed. At Carlson/J, two bicycle crashes occurred when the bicyclist was attempting to cross in the crosswalk. The third crash occurred when the bicyclist was turning left from south to east. The report indicated that the bicyclist was intoxicated and was killed when she ran the red light. The bicycle crash that occurred 900 feet west of the Carlson/J involved a bicyclist riding on the wrong side of the road and was hit by a turning vehicle.

An unusually large number of fatalities occurred between 2010 and 2014. At Carlson/H a fatal car versus bicycle crash occurred in 2010 and a fatal multi-vehicle crash occurred in 2013. At Carlson/J a fatal car versus bicycle crash occurred at in 2011. Despite the overall low number of crashes at this location, the number of fatalities within recent years has raised concern in the community, especially since two out the three fatalities involved bicyclists.



Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

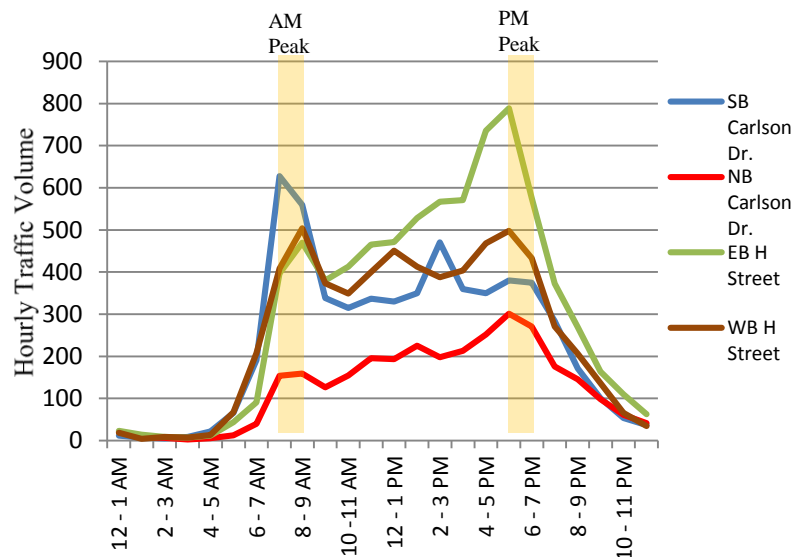
Traffic Counts for Carlson/H:

The City of Sacramento hired consultants to conduct turning movement counts at the Carlson Drive/H Street and Carlson Drive/Newman Court intersections on Tuesday, April 12, 2011 from 7 to 9 AM and from 3 to 6 PM. The counts included observations of vehicles (classified as either passenger cars or buses), bicycles, and pedestrians. The AM peak hour occurred from 7:30 to 8:30 AM while the PM peak hour occurred from 4:30 to 5:30 PM. Weather conditions were clear and dry. No unusual traffic events were observed. Sacramento State was in session at the time of the traffic counts.

The illustration on the following page displays the existing peak hour turning movements including vehicles, bicycles, and pedestrians. Below are some key observations from this data:

- H Street west of Carlson Drive exhibits a peak hour, peak direction traffic flow pattern (AM peak hour is heavier westbound and PM peak hour is heavier eastbound).
- Carlson Drive north of H Street exhibits a traditional residential travel pattern (higher volumes departing the community during the AM peak hour and returning during the PM peak hour).
- Carlson Drive south of H Street has heavier southbound volumes than northbound volumes (due to westbound-only H Street east of Carlson Drive).
- Bicyclists were observed on all approaches to the intersection, with the heaviest flow occurring for the eastbound right turn during the PM peak hour.
- Traffic counts revealed 23 AM peak hour and 3 PM peak hour buses that traveled through the intersection. The AM buses included a combination of Regional Transit (RT), school, and other buses.

Daily traffic counts were conducted on each approach to the intersection on Tuesday, April 12th and Wednesday, April 13th. The chart to the right shows the average hourly traffic volume profile on each approach. The data shows that traffic volumes are greatest on three of the four approaches during the evening peak hour (4:30 to 5:30 PM). However, the sum of the PM peak hour volumes (1,987 vehicles) is only two percent greater than the sum of the AM peak hour volumes (1,943 vehicles).



The average daily (vehicular) volume on each approach to the intersection is as follows:

- Southbound Carlson Drive: 5,700 vehicles per day
- Northbound Carlson Drive: 3,100 vehicles per day
- Eastbound H Street: 7,500 vehicles per day
- Westbound H Street: 6,100 vehicles per day



CARLSON/H INTERSECTION
PEAK HOUR TRAFFIC VOLUMES – CONDITIONS ON
APRIL 12TH, 2011

Traffic Counts for Carlson/J:

The City of Sacramento hired consultants to conduct turning movement counts at the Carlson Drive/J Street intersection on Tuesday, May 3, 2011 from 7 to 9 AM and 3 to 6 PM. The counts included observations of vehicles (classified as either passenger cars or buses), bicycles and pedestrians. Sacramento State was in session at the time of the traffic counts. The AM peak hour occurred from 8:00 to 9:00 AM while the PM peak hour occurred from 4:30 to 5:30 PM. Weather conditions were clear and dry for the counts.

The illustration on page 27 displays the existing peak hour turning movements including vehicles, bicycles, and pedestrians. Below are some key observations from this data.

Vehicular Traffic Volumes

- Vehicular traffic volumes on California State University Drive are highly peak-hour and peak-directional. During the AM peak hour, 1,430 vehicles enter the campus, and during the PM peak hour, 1,130 vehicles exit the campus. About two-thirds of these trips are distributed to/from the east on J Street.
- J Street east of Carlson Drive carries significantly greater levels of westbound traffic during the AM peak hour and eastbound traffic during the PM peak hour due to the effects of Sacramento State related traffic. Traffic volumes on J Street west of Carlson Drive are slightly heavier in the eastbound direction during both peak hours. The following three movements are particularly critical to overall intersection operations:
 - Westbound J Street Left-Turn: 900, U-Turn: 23 vehicles during AM peak hour
 - Southbound Carlson Drive Left-Turn: 577 vehicles during PM peak hour
 - Northbound Calif. State University Drive Right-Turn: 782 vehicles during PM peak hour

Truck / Bus Volumes

- During the AM peak hour, 18 trucks and 43 buses were observed passing through the intersection. The predominant truck movements were westbound through and southbound right-turns. About 80 percent of the buses were observed to turn into/out of the Sacramento State campus.
- During the PM peak hour, 10 trucks and 33 buses were observed passing through the intersection. All buses were observed to turn into/out of the Sacramento State campus.
- A pedestrian call is placed on the west leg crosswalk nearly every cycle during both peak hours. This, combined with the extensive east-west green intervals, results in cycle lengths that consistently exceed two minutes. This also causes long vehicle queues including the following:
 - Southbound Carlson Drive traffic spills back into H Street every 5 to 10 minutes during the PM peak hour.
 - Eastbound through traffic during the PM peak hour queues a substantial distance (queue was more than 20 vehicles per lane) back from the study intersection.
 - Eastbound left-turn movement queue exceeds 160-foot turn pocket during both peak hours.
 - Northbound traffic spilled back to the California University Drive North intersection during the PM peak hour.

Bicycle and Pedestrian Volumes

- Bicycle travel occurs on all legs of the intersection. The following movements experience the greatest levels of bicycle travel:

Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

- Southbound Carlson Drive Left-Turn: 29 bicyclists during PM peak hour
- Eastbound J Street Through: 25 bicyclists during PM peak hour
- Southbound Carlson Drive Through: 12 bicyclists during AM peak hour
- Eastbound J Street Right-Turn: 12 bicyclists during AM peak hour

The first two movements listed above are associated with bicycle travel to the American River Parkway. The last two movements listed above are associated with travel into Sacramento State.

- Approximately 90 persons during each peak hour were observed to use the crosswalk on the west leg of the intersection. Given the lack of a crosswalk on the east leg, all crossings of J Street in the vicinity occur at this crosswalk.
- The table below summarizes bicycle and pedestrian volumes at the intersection during the AM, mid-day and PM peak periods.

Bicycle and Pedestrian Volumes			
Movement	AM Peak Period (7 - 9 AM)	Mid-Day Peak Period (11:30 AM – 1:30 PM)	PM Peak Period (3 – 6 PM)
<i>Bicyclists</i>			
Westbound J Street Approach	1	0	5
Eastbound J Street Approach	49	15	84
Southbound Carlson Drive Approach	28	9	39
Northbound California State University Dr. Approach	1	9	30
<i>Pedestrians</i>			
West Leg Crosswalk	136	225	202
South Leg Crosswalk	50	61	98
North Leg Crosswalk	18	34	42



CARLSON/J INTERSECTION
 PEAK HOUR TRAFFIC VOLUMES – CONDITIONS ON
 MAY 3RD, 2011

Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

Problem Statement:

The intersections of Carlson/H and Carlson/J experience a significant amount of vehicular, bicycle and pedestrian traffic. The current configurations to these intersections have largely been oriented to motor vehicle users. The improvements proposed with this project are aimed at improving access for bicyclists and pedestrians who access nearby destinations such as Sacramento State University, River Park Neighborhood and the bike path that runs along the American River Parkway. Traffic counts taken for these intersections show the needs for bicyclists and pedestrians are higher here than at most areas of the City. Crash history of the area, especially with the recent bicycle crash fatalities, shows that better accommodation for bicyclists and pedestrian would be beneficial.

Both the Carlson/H and Carlson/J intersections are challenging intersections for bicyclists. To address this, several bicycle infrastructure items are proposed. This application is requesting to install experimental devices is aimed at improving that ability for bicyclists to make left turns in these intersections. While “vehicular style” left turns can be accomplished with the current configurations, high levels of traffic and greater than average number of bicyclists in the area suggest that more options be provided.

Proposed Treatment:

Some of the improvements already implemented at these intersections have been implemented in conformance with the California Manual on Uniform Traffic Control Devices (CA-MUTCD). These include the traffic signal upgrades, additional signage, the use of bike lanes with the use of green colored pavement and the striping of buffered bike lanes. This application proposes to provide an experimental installation of additional pavement markings to assist bicyclist in left turning movements and, to a lesser degree, for through movements. These will be made possible by the combination of “bike boxes” and “two-stage left turn queue boxes.”

Bike boxes

Bike boxes provide a method for bicyclist to move across travel lanes to be best positioned to make a left turn at a time while traffic is stopped at a red light. The design extends the bike lane laterally across vehicular through lanes to the rightmost left turn lane. This space is directly behind the crosswalk and is a nominal ten feet wide. In many ways it functions similarly to an advanced stop line, a feature already available in the CA-MUTCD. The difference is that the bike box has additional markings to encourage bicyclists to use this space to position themselves in front of the queue of vehicles prior to the traffic signal changing to green. While the main purpose of the bike box is to allow bicyclists to position themselves in front of the left turning queue, a supplemental benefit is that it will provide through-bound bicyclists a waiting space in front of the through-bound queue. The proposed bike box will use green colored pavement and white bicycle symbols to encourage using the space and establishing proper lane positioning.

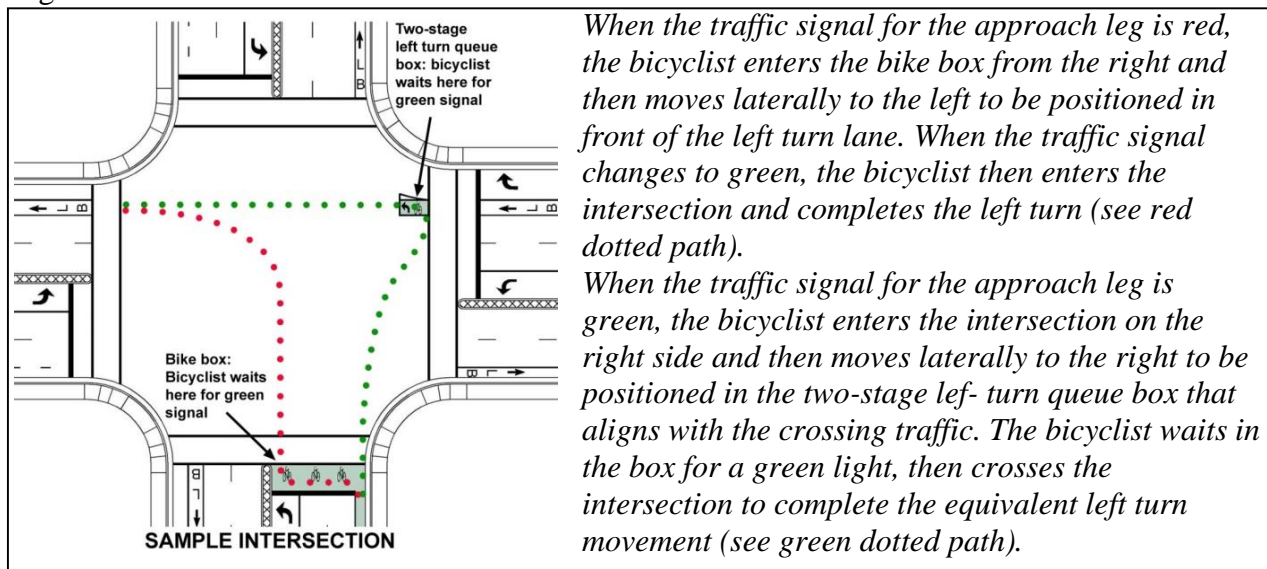
Two-Stage Left-Turn Queue Box

The two stage left turn queue box is a designated space in the intersection where left turning bicyclist may occupy while making a two stage left turn. Two stage crossing is accomplished when the bicyclist crosses part of the intersection while the traffic signal is green and stops in a designated space outside of the flow of vehicular traffic. While stopped, the bicyclist re-orient the bicycle to face the crossing direction, and waits for the traffic signal to turn green to proceed

Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

across the intersection. The shape and location of the two stage box is dependent upon the available pavement space, but the general concept is to make a designated space large enough for a bicyclist to enter, reposition and wait for a green light without intruding on any adjacent traffic, such as right turning movements. The proposed two stage box will use green colored pavement a white bicycle symbol, a reduced-size white left turn arrow pavement marking and white striping around the border.

The illustration below shows how the combination of bike box and two stage box can work together:



Bike boxes by themselves are useful to bicyclists who are approaching the intersection and the traffic signal is red and vehicles are stopped. This is often the case where a minor street crosses a major street and the traffic signal for the minor street is red until a call is made for a green light. Two-stage left-turn queue boxes are useful to bicyclists who are approaching the intersection and the traffic signal is green and vehicles are moving. This is often the case where a major street crosses a minor street and the traffic signal for the major street is green until a call is made to change it to a red light. When two major streets intersect, the time allotted to either direction is split, therefore, vehicles have equal chance of seeing a red or green traffic signal upon approach. In this case, a combination of both bike box and two-stage left-turn queue box are most appropriate. This is the case at the intersection at the Carlson/J intersection. The proposal for this location is to install both bike boxes and two-stage left-turn queue boxes. The combination of the two devices will allow left turning bicyclist to have more choices to execute a left turn.

FHWA Guidance on bike boxes:

Although bike boxes are experimental, the FHWA has published some guidance on their installation. These are found at the following web link:

www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/mutcd/bicycle_box.cfm



Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

Required elements:

- Advance stop bar, and
- Bicycle symbol pavement marking(s), and
- Full-time turn on red prohibition, and
- The bicycle box must be setback (setback) from the adjacent crosswalk or pedestrian crossing movement if a crosswalk is not present. The bicycle box cannot be contiguous to the crosswalk, and
- Pedestrian countdown signals must be present or installed for the contiguous crosswalk movement if the bicycle box is installed laterally across more than one approach lane, and
- Where an existing, advance stop bar is relocated to accommodate the installation of the bicycle box, a recalculation of the yellow change and red clearance intervals is required (see Section 4D.26) to accommodate the length of the bicycle box and the new setback. This signal timing analysis will not need to be submitted with their request to experiment for FHWA review or approval. The agency is to retain the signal timing analysis on file with their request to experiment in the event the FHWA needs to access the signal timing analysis at a later date.

Optional element:

- Green colored pavement

FHWA Guidance on two-stage left-turn queue boxes:

Although bike boxes are experimental, the FHWA has published some guidance on their installation. These are found at the following web link:

www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/mutcd/turn_box.cfm

Required design elements include:

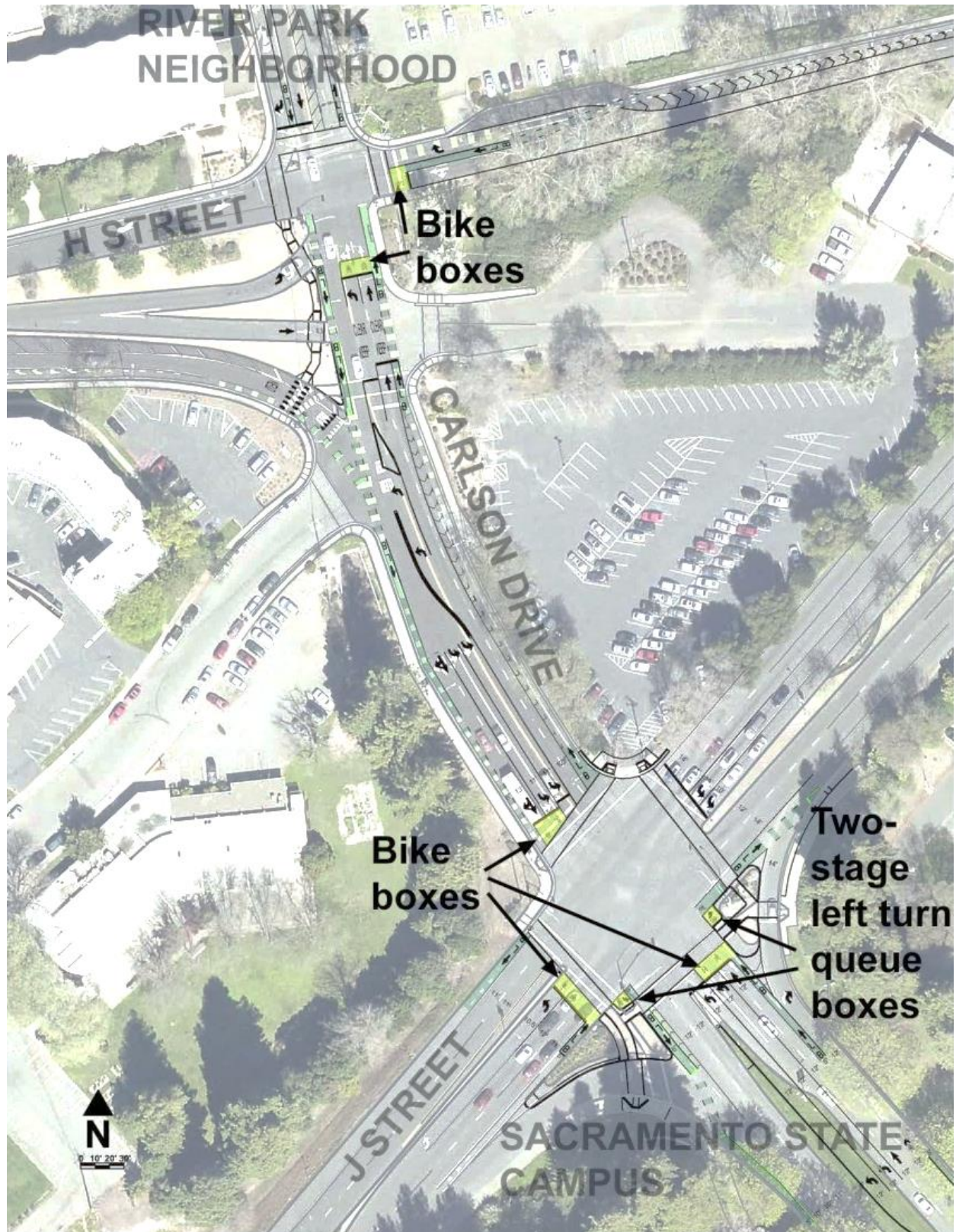
- Bicycle symbol pavement marking, and
- Pavement marking turn or through arrow, and
- Full-time turn on red prohibition for the cross street, and
- Passive detection of bicycles if the signal phase that permits bicyclists to enter the intersection during the second stage of their turn is actuated.

The size of the two-stage left-turn queue box should consider peak hour bicycle volumes and adjacent land uses to accommodate multiple users so that overflow of the two-stage turn box does not subject any bicyclist to conflicting movements.

Optional design elements include:

- Green-colored pavement
- Signing

The illustration below shows the proposed installation for Carlson/H and Carlson/J intersections:



Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento



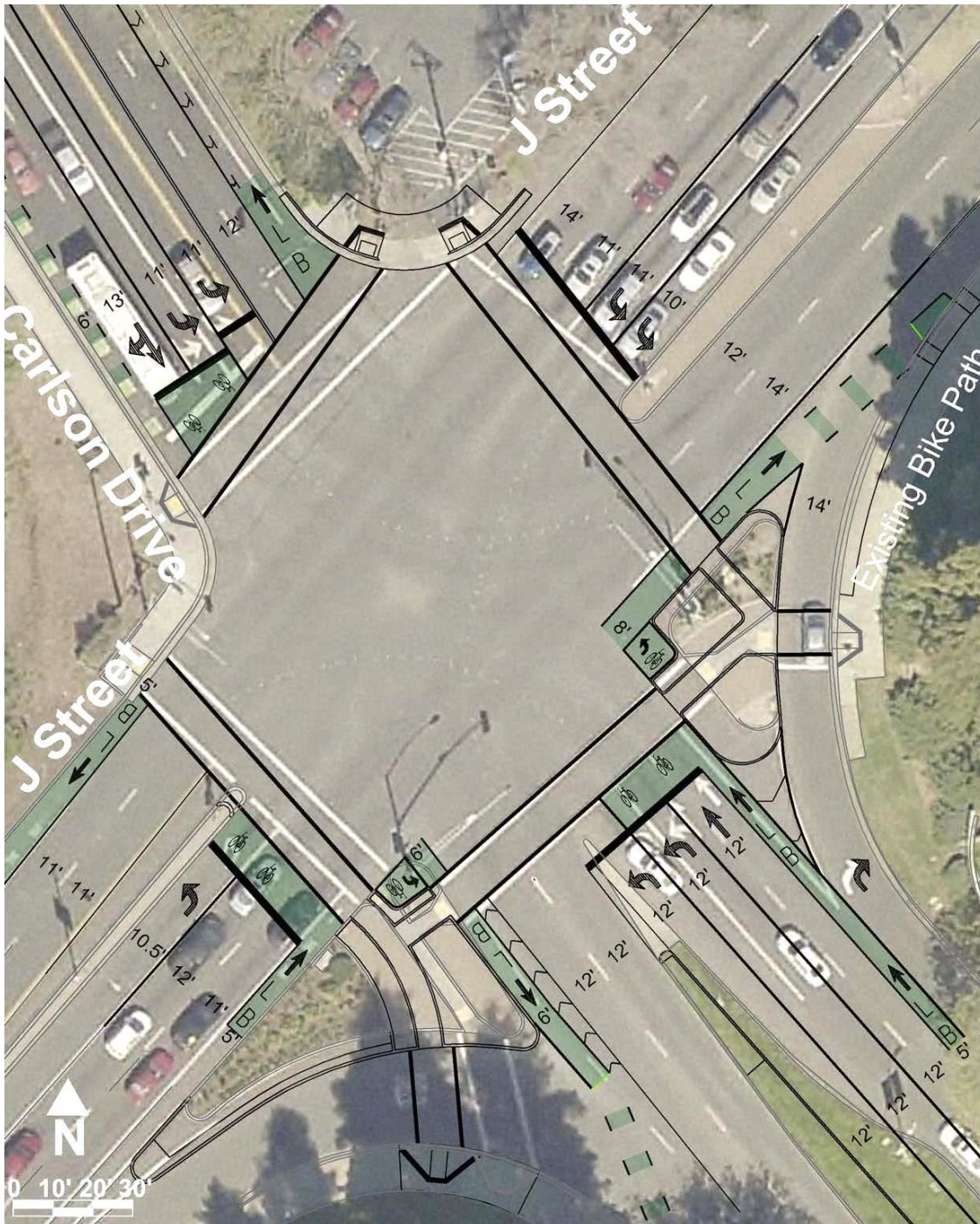
Carlson/H Intersection

Bike boxes are being provided at the northbound and westbound approaches. Since the east leg of the intersection is one way westbound, there is no need to provide for south to east left turning bicycles. A bike box is also not proposed for the eastbound on H Street approach. This is because the left turn lane is channelized with concrete islands and cannot be configured for a bike box. Two-stage left turn queue boxes are not being considered for this intersection. See illustration below:

Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

Carlson/J Intersection

Bike boxes are being provided at the northbound, southbound and eastbound approaches. The westbound approach is not proposed due to the lack of a bike lane for this part of J Street. Most of the bicycle traffic going westbound uses the bike path that runs along the south side of the east leg of J Street. Two-stage left turn queue boxes are proposed for the eastbound and southbound directions. They are integrated into the right turning channelizing islands for right turning traffic into and out of the Sacramento State Campus. See illustration below:



Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

Supporting Statements:

FHWA has approved at least 25 requests to experiment with bike boxes between 2008 and 2015. This device will remain experimental until more results are obtained from crash data analysis, conflict/avoidance maneuvers between motorists and bicyclists and motorist and bicyclist compliance with turn on red prohibition.

FHWA has approved at least 11 requests to experiment with two-stage left-turn queue boxes between 2011 and 2015. This device will remain experimental until standards for signage are developed that can provide regulatory information for enforcement purposes and/or navigational guidance consistent with conventional guide sign designs.

Both bike boxes and two-stage left- turn queue boxes are identified in the National Association for City Transportation Officials (NACTO) Urban Bikeway Design Guide for signalized intersections. The following excerpts from the guide indicate the advantages for each treatment:

Bike Box:

- Increases visibility for bicyclists.
- Reduces signal delay for bicyclists.
- Facilitates bicyclist left turn positioning at intersections during red signal indication.
- Helps prevent “right hook” conflicts with turning vehicles at the start of the green signal indication.
- Groups bicyclists together to clear an intersection quickly, minimizing impediment to transit or other traffic.
- Pedestrians benefit from reduced vehicle encroachment in the crosswalk.

Two-Stage Left-Turn Queue Box:

- Improves bicyclist ability to safely and comfortably make left turns.
- Provides a formal queuing space for bicyclists making a two-stage turn.
- Reduces turning conflicts arising from bicyclists queuing in a bike lane or crosswalk.
- Separates turning bicyclists from through bicyclists.

Copyright Compliance:

To the best of the City of Sacramento’s knowledge, the concept of using bike boxes and two-stage left turn queue boxes to supplement standard traffic control devices are not protected by patents or copyrights.

Experiment Time Period:

Construction is expected to be complete in 2016. The experiment will be one year period afterwards.

Evaluation Plan:

The bike boxes and two-stage left turn queue boxes will be evaluated before and after the installation:

Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

<u>Evaluation metric</u>	<u>Evaluation Method</u>
Crash reduction analysis	Review and present crash report records from previous 5 years and one year subsequent to installation
Incidents of vehicle/bicycle conflicts	Peak hour observation of crossing and yielding behavior.
Conflicts/avoidance maneuvers among vehicle/bicycle movements	Peak hour observation of crossing and yielding behavior.
Bicyclist position approaching bike box	Peak hour observation of bicyclist movements.
Bicyclist position approaching two stage left turn queue box	Peak hour observation of bicyclist movements.
Bicyclist position bike box	Peak hour observation of bicyclist queuing.
Bicyclist position at two-stage left-turn queue box	Peak hour observation of bicyclist queuing.
Motor vehicle position queued at the intersection	Peak hour observation of motor vehicle queuing.
Traffic counts	Peak hour counts for bicyclists and motorists

Agreement to Restore:

The City of Sacramento will restore the site of the experiment to a condition that complies with the provisions of the CA-MUTCD, which in this case, would be to remove the bike boxes and the two-stage left turn queue boxes upon determination that the installation of the treatments was not effective. The City further will commit to terminate the experiment if the City, The California Traffic Controls Devices Committee (CTCDC) or the Federal Highway Administration (FHWA) determines that significant safety concerns are directly or indirectly attributable to the experimental treatment. The City understands that if, as a result of the experiment, a request is made that the CA-MUTCD is changed to include the treatments used in this experiment, the treatment will be permitted to remain in place until an official rule making action has occurred.

Reporting Frequency:

Progress reports will be prepared every six months for the duration of the experiment for one year. A final report will be provided within three months following the completion of the experiment.

Item 16-06 Request to experiment with Bike Boxes and Two-stage Left-turn Queue Boxes in the City of Sacramento

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

Recommendation: The CTCDC is requested to grant approval for SFMTA to experiment with signage and pavement markings at light rail boarding locations.

Agency Making Request/Sponsor: SFMTA/Sallaberry - Active Transportation, voting member

Background:

The San Francisco Municipal Transportation Agency (SFMTA) requests permission to conduct an experiment using modified signage and pavement markings requiring vehicles to stop mid-block behind a light rail vehicle (LRV) that is stopped to board or alight passengers where no safety zone exists. The purpose of the experiment is to determine the effectiveness of the proposed signage and pavement markings in improving compliance with California Vehicle Code (CVC) Section 21756 and improving safety for passengers boarding and alighting LRVs.

1. PROBLEM STATEMENT

The majority of the SFMTA's 2.7-mile L-Taraval surface LRV route runs on Taraval Street, from 15th Avenue to 46th Avenue. Taraval Street is 60 feet wide, with two lanes in each direction and parallel parking on both sides. LRVs travel in the left lanes in each direction and board/alight passengers from/to the right lane at most transit stops. There are no established safety zones at 23 of the 27 transit stops.

CVC Section 21756 governs the actions of vehicles when LRVs are stopped to alight and board passengers. The regulation requires vehicles to stop behind the nearest door of the LRV where no safety zone exists. The California Manual on Uniform Traffic Control Devices Section 8B.14 provides guidance for the use of regulatory signs R15-5 and R15-5a at LRV transit stops where no safety zone exists.

In the past five years of available data (2009-2013), there were 45 injury collisions between vehicles and pedestrians along the surface route of the L-Taraval, 22 of which involved a person either boarding or alighting a LRV. These collisions occurred despite the presence of R15-5 signs at each transit stop, due to high rates of non-compliance with the requirement to stop (approximately 33% of drivers).

2. PROPOSED SOLUTION

The SFMTA requests permission to conduct an experiment using:

- (1) Modified signage to require vehicles in the right lane to stop behind a LRV that is stopped to board or alight passengers. The proposed sign will be complemented with a 12-inch solid white limit line. The proposed sign and limit line will be located approximately 150 feet upstream of the intersection to match the length of the typical LRV configuration (2-car trains). See Attachment 1 for the proposed sign and Attachment 3 for the proposed pavement markings.

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

- (2) Modified pavement markings applied to the right travel lane in the form of a crosshatch pattern in the area between the midblock limit line and the intersection crosswalk to alert vehicles that they are approaching a special zone where LRV passengers board and alight. The dimensions of the patterned area are approximately 110 feet long by 12 feet wide. Please see Attachment 3 for a drawing of the proposed pavement markings and Attachment 4 for a visual mockup.

3. OBJECTIVE

The objective of the experiment is to determine the usage and effectiveness of the proposed signage and pavement markings in improving compliance with CVC Section 21756 and improving safety for passengers boarding and alighting LRVs.

4. EXPERIMENT SCHEDULE

- Pre-Installation Evaluation: January to March 2016
- Installation: March to April 2016
- Experimental Period: April to October 2016
- Evaluation of Results: October to December 2016

Thank you for your kind consideration of this request to experiment. The SFMTA looks forward to receiving a positive response from the Committee. If you have any questions, please contact Robert Lim of my staff at (415) 701-5669 or robert.lim2@sfmta.com.

Sincerely,

Ricardo Olea
City Traffic Engineer

Additional BACKGROUND

The San Francisco Municipal Transportation Agency (SFMTA) directly oversees Muni, one of America's oldest public transit systems, and its five transit modes (motor coach bus, electric trolley bus, light rail, historic streetcar, and cable car). Muni operates 6 light rail vehicle (LRV) routes, all of which serve a combination of surface streets and an underground subway. Of all the routes, only the L-Taraval boards/alights passengers from/to a live lane of traffic without any protection from vehicles through either a boarding island or a transit sidewalk bulb-out at a majority of stops.

The L-Taraval carries 29,000 passengers per day and operates along a 2.7-mile surface route in each direction, in addition to a portion that is in a subway. The majority of the surface route is on Taraval Street and is 60 feet wide, with 2 travel lanes in each direction and parking on each side of the street. The LRV travels on the inside lane of each direction and boards/alights passengers from/to traffic lane #2. There are no established safety zones on Taraval Street such as boarding islands or transit sidewalk bulb-outs on 23 of the 27 transit stops. San Francisco is the only city in California that has LRVs board/alight passengers to an active traffic lane; as a result, this problem is unique to this jurisdiction.

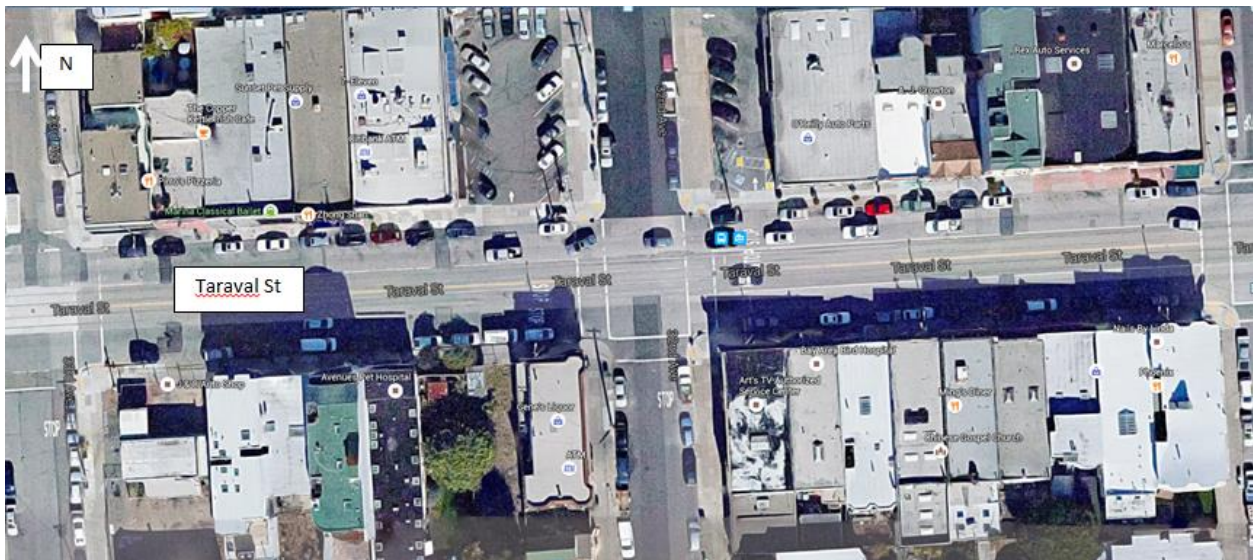


Figure 1. Aerial Map of Taraval Street (via Google Maps)

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

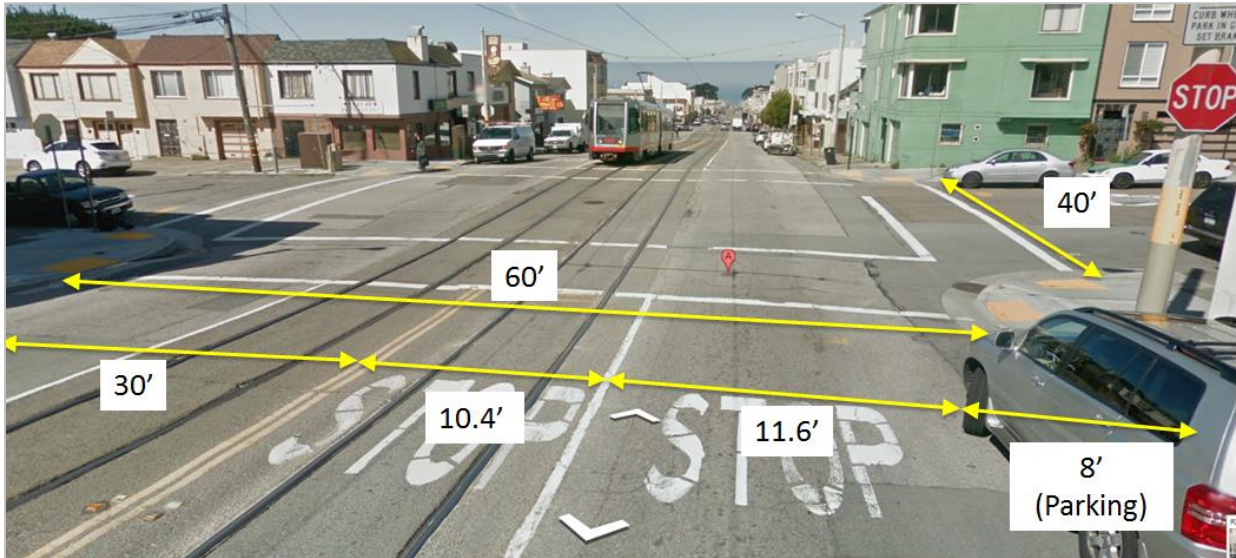


Figure 2. Taraval Street Lane Configuration, looking west (via Google Maps)

In the past 5 years of available data (2009-2013), there were 45 total collisions between vehicles and pedestrians along the surface route of the L-Taraval. Twenty-two (22) of these collisions occurred when a person was either boarding or alighting the LRV. None were fatal, but all collisions included some level of reported injury.

The boarding/alighting vehicle-pedestrian collisions occurred despite an existing California Vehicle Code (CVC) that regulates vehicle behavior during the presence of LRVs. Section 21756 states that:

- (a) The driver of a vehicle overtaking any interurban electric or streetcar stopped or about to stop for the purpose of receiving or discharging any passenger shall stop the vehicle to the rear of the nearest running board or door of such car and thereupon remain standing until all passengers have boarded the car or upon alighting have reached a place of safety, except as provided in subdivision (b) hereof.
- (b) Where a safety zone has been established or at an intersection where traffic is controlled by an officer or a traffic control signal device, a vehicle need not be brought to a stop before passing any interurban electric or streetcar but may proceed past such car at a speed not greater than 10 miles per hour and with due caution for the safety of pedestrians.
- (c) Whenever any trolley coach or bus has stopped at a safety zone to receive or discharge passengers, a vehicle may proceed past such trolley coach or bus at a speed not greater than 10 miles per hour.

Section (a) applies specifically to Taraval Street, where most stops do not have a safety zone. The accompanying proposals seek to improve vehicle compliance to CVC 21756(a). There is a direct correlation between CVC 21756(a) compliance and improved safety for passengers who board and alight.

SCOPE

The SFMTA requests permission to conduct an experiment using modified signage and striping to have vehicles stop mid-block behind a light rail vehicle (when one is present) as a non-standard traffic

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

control device to determine their effectiveness in improving the safety of passengers boarding and alighting a LRV and compliance with the existing law.

The two part proposal involves:

- (1) Modified signage to require vehicles in the #2 travel lane to come to a stop behind a LRV that is stopped for the purpose of receiving or discharging any passenger midblock. The sign will be complimented with a 12" solid white limit line. The new sign and striping will be located approximately 150 feet upstream of the intersection to match the length of the typical LRV configuration (2-car trains). The exact distance of the signage and limit line may vary slightly to accommodate space on the sidewalk to mount a pole for the new sign. See Attachment 1 for the proposed sign and Attachment 3 for the modified striping.
- (2) Modified striping applied to the #2 travel lane in the form of a crosshatch pattern (8" solid white) in the area between the midblock limit line and the intersection crosswalk to alert vehicles that they are approaching a special zone where LRV passengers get on and off the train. The dimensions of the patterned area are approximately 110 feet long by 12 feet wide. Please see Attachment 3 for a drawing of the modified striping and Attachment 4 for a visual mockup. These would be similar to "Do Not Block Intersection" crosshatch markings (previously included in Section 3B.17 of the California MUTCD).

Vehicles are required to remain stopped during the duration of active boarding and alighting (i.e. when LRV doors are open). Vehicles are not required to adhere to the proposed sign and accompanying striped midblock limit line when a LRV is not present or when there is no active boarding and alighting (LRV doors are closed).

The main objective of the experiment will be to determine the usage and effectiveness of the modified traffic signage and striping in improving vehicle compliance to CVC section 21756(a). Vehicle compliance to the proposed signage and striping changes will improve the safety of people getting on and off the LRV and result in the reductions of related vehicle-pedestrian collisions.

Locations to experiment the proposal were chosen based on:

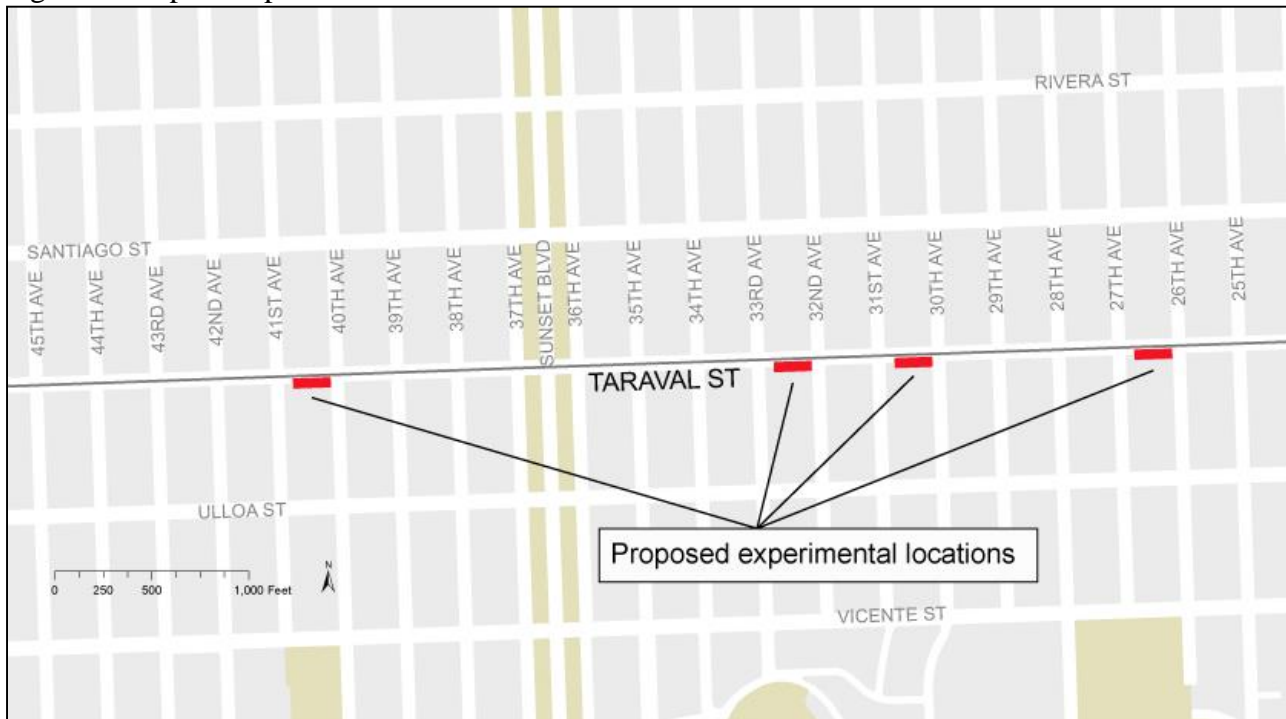
- (1) where there were few or no injury collisions involving passengers getting on/off the LRV in the 5 year study period (2009-2013)¹
- (2) presence of businesses on the block

Four (4) inbound (LRV heading towards Downtown San Francisco) locations were selected based on the above criteria:

- (1) Taraval Street @ 26th Avenue
- (2) Taraval Street @ 30th Avenue
- (3) Taraval Street @ 32nd Avenue
- (4) Taraval Street @ 40th Avenue

¹ At all other surface L Taraval stops on Taraval Street, the SFMTA is pursuing the addition of full boarding islands, which require the removal of parking.

Figure 3. Map of Experimental Locations



No outbound stops (LRV heading west) were included because the risk to passengers is generally higher when alighting than boarding, and outbound stops typically have higher volumes of passengers alighting. Thus we are recommending a permanent solution of boarding islands to address injury concerns for the outbound portion, and at inbound stops with higher volumes of alighting. Because implementing boarding islands would result in the loss of parking on Taraval Street for locations with transit stops, we are addressing neighborhood concerns by agreeing to try the experimental proposals, though only at these four inbound locations where the risk of collisions is lower than other stops on Taraval Street. Additional locations to the selected four may also be considered for experimentation pending feedback from the outreach process however.

Implementation of possible future permanent inbound boarding islands would be dependent on the final evaluation of this proposal.

ALTERNATIVES CONSIDERED

Alternatives considered include installing boarding islands and sidewalk bulb-outs at the four proposed locations. However, due to neighborhood concerns from residents and businesses with traffic and parking, the SFMTA agreed to seek other options to address the issue of non-compliance with CVC 21756 for four inbound stop locations.

WORK PLAN AND EVALUATION PROCEDURES

The signage and striping proposals will be installed by SFMTA crews. Possible issues that may result of the implementation of this proposal include that pedestrians may confuse the patterned area as a place to wait for a LRV when there is not an LRV present, and that cars in the #2 lane may stop behind

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

the midblock limit line even when a LRV is not actively alighting or boarding passengers. However, we do not envision that people will take the patterned area as a waiting area because there is no physical protection from the active traffic lane, and it does not resemble any existing pedestrian safety zones. Also, properly placed signage should relieve concerns about vehicles stopping when there is no active LRV boarding or alighting passengers. SFMTA would closely monitor the behavior of pedestrians and drivers around these stops if the proposed changes are implemented to ensure there are no new safety issues occurring.

The effectiveness of the pilot treatments would be evaluated based on a field study of driver compliance with the requirement to stop when trains are boarding or about to board. At each of the four pilot stop locations, surveyors will gather a sample of 100 observations immediately before the pilot is in effect, midway through the pilot, and six months into the pilot. Additionally, a “calibration” dataset of about 25 observations at each of the four pilot locations is being gathered to test and refine the data collection instrument and establish a baseline compliance rate for planning purposes. Preliminary data shows that approximately 33% of vehicles are in non-compliance.

After the calibration dataset is collected, a target compliance rate will be set. This target will need to be set at a very high rate of compliance to ensure that risk to pedestrians boarding and alighting the L Taraval face virtually no risk of being hit by drivers. If this target is not met, the SFMTA would remove the new signage and striping and replace it with either boarding islands or another treatment.

TIME PERIOD

- | | |
|-------------------------------|--------------------------|
| • Pre-Installation Evaluation | January to March 2016 |
| • Installation | March to April 2016 |
| • Experimental Period | April to October 2016 |
| • Evaluation of Results | October to December 2016 |

REPORTING

The SFMTA will submit a final report evaluating the proposal at the conclusion of the experiment in January 2017 to the CTCDC.

REMOVAL OF EXPERIMENTAL INSTALLATIONS

The SFMTA will remove experimental installations within three months of a determination by the CTCDC or FHWA that changes to the MUTCD or CA MUTCD are not warranted. Additionally, the SFMTA will terminate the experiment if significant safety concerns are found to be attributable to the experiment.

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

ADMINISTRATION

Sponsoring Agency: San Francisco Municipal Transportation Agency

Contact Information: Robert Lim, P.E.
Transportation Engineer
415-701-5669
Robert.Lim2@sfmta.com

Installation: SFMTA Traffic Sign and Paint Shops

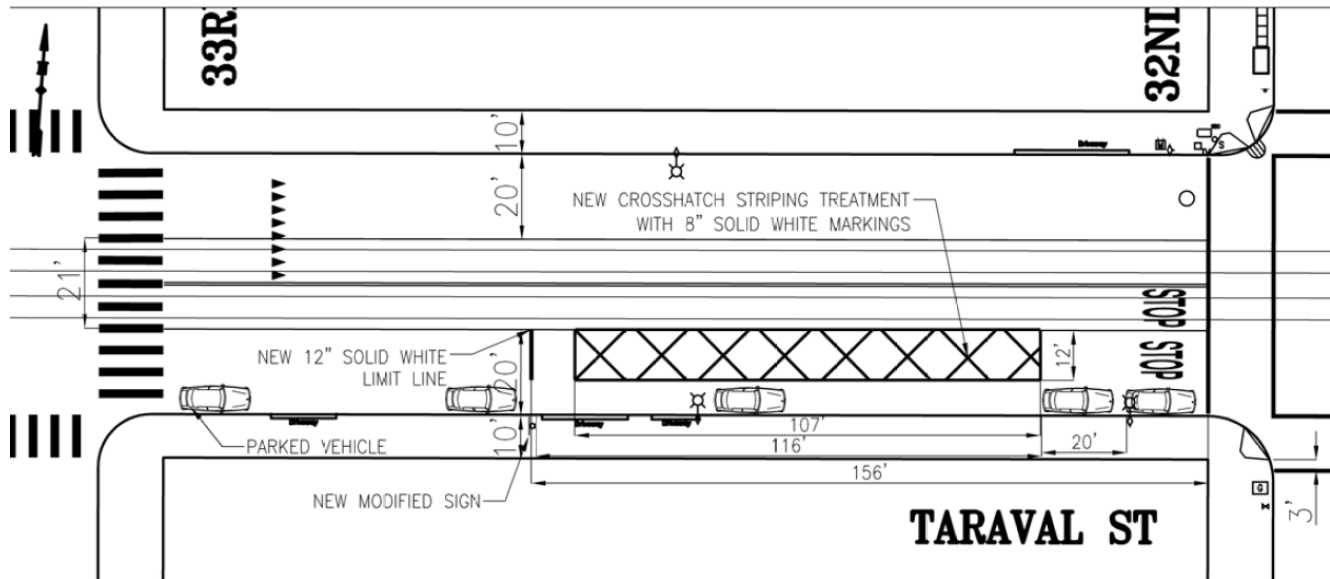
Attachment 1: Proposed Signage**Attachment 2: Existing MUTCD Standardized Signage Used to Create New Proposed Signage**

R15-5



R10-6

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

Attachment 3: Proposed Striping Modifications**Attachment 4: Visual Mockup of Proposed Signage and Striping**

Item 16-07 Request to experiment with modified signage and pavement markings requiring vehicles to stop behind light rail vehicles stopped to board or alight passengers

Item 16-08 Request for Permission to Experiment with the Diagonal Down Yellow Arrow Lane Use Control Signal Indications on Freeways

Recommendation: The CTCDC is requested to grant approval for Caltrans to experiment with diagonal down yellow arrows on freeways

Agency Making Request/Sponsor: Caltrans/Tong, voting member

STATE OF CALIFORNIA—CALIFORNIA STATE TRANSPORTATION AGENCY

EDMOND G. BROWN JR., Governor

DEPARTMENT OF TRANSPORTATION

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*Flex your power!
Be energy efficient!*

February 19, 2016

Mr. Chris Engelmann
Executive Secretary
California Traffic Control Devices Committee – MS36
P.O. Box 942874
Sacramento, CA 94274-0001

Subject: Request for Permission to Experiment with the Diagonal Down Yellow Arrow Lane Use Signal Indications on Freeway

Dear Mr. Engelmann:

In accordance with the California Manual on Uniform Traffic Control Devices (CA MUTCD) Section 1A.10, the California Department of Transportation (Caltrans) – District 4 is requesting approval of the diagonal down yellow arrow lane use signal indication for experimental use on the Interstate 80 (I-80) Smart Corridor Project in San Francisco Bay Area.

The I-80 Smart Corridor Project (also known as the I-80 Integrated Corridor Mobility Project) has deployed an innovative suite of technological strategies for improving safety and mobility, proactively managing traffic congestion and incidents, and enhancing traveler information. One of the active traffic management (ATM) strategies is to display the diagonal down yellow arrow lane use signal indication on overhead gantries to communicate the need for motorists to merge into an adjacent lane due to a temporary lane closure downstream.

Thank you for your consideration of this request. Caltrans is looking forward to receiving a positive response from the Committee. If you have any questions, please contact the I-80 Corridor Manager, David Man at (510) 286-4607.

Sincerely,

S. Sean Nozzari
Deputy District Director
Traffic Operations

Item 16-08 Request for Permission to Experiment with the Diagonal Down Yellow Arrow Lane Use Control Signal Indications on Freeways

Background:**A. Nature of the problem**

The Interstate 80 (I-80) Smart Corridor project is located along a 20.5 mile corridor running from the interchange of I-80/I-580/I-80 in Oakland to the Carquinez Bridge in Crockett (**Figure 1**). The corridor is located within Alameda and Contra Costa Counties and includes alternative parallel arterial routes, transit services and crossing arterials that connect these facilities. The commute periods are directional with the peak morning commute in the westbound direction and evening peak in the eastbound direction; there is also considerable congestion in the off-peak direction in some locations. There is considerable weekend traffic congestion in both directions along the southern portion of the corridor within Alameda County.

As part of the I-80 Smart Corridor project, the California Department of Transportation (Caltrans), in partnership with Alameda County Transportation Commission (Alameda CTC), Contra Costa Transportation Authority (CCTA) and the local agencies along the project corridor, is preparing to deploy active traffic management (ATM) systems at several locations along the project corridor in the San Francisco Bay Area to increase mobility, improve safety, enhance incident management, maximize roadway capacity, and promote environmental sustainability.

As part of this project, Caltrans would like to use a diagonal down yellow arrow lane use signal (LUS) indication to communicate the need for motorists to merge into an adjacent lane due to a temporary lane closure downstream. The diagonal down yellow arrow indication provides motorists information (i.e., merge and the merge direction) that is not conveyed by the *California Manual on Uniform Traffic Control Devices (CA MUTCD)*, 2014 Edition standard yellow “X”, which indicates that a motorist should “prepare to vacate the lane over which the signal indication is located.” Caltrans bases this request to use a diagonal down yellow arrow LUS in lieu of a yellow “X” based on recent research and experimentation that has demonstrated the effectiveness of this proposed traffic control device. These indications are used in European ATM projects,² and several prior studies have shown benefits in terms of driver comprehension.^{3,4} The Texas Transportation Institute carried out field experiments and driver

Figure 1 - Project Area

² Tignor, S.C., Brown, L.L., Butner, J.L., Cunard, R., Davis, S.C., Hawkins, H.G., Fischer, E.L., Kehrli, M.R., Rusch, P.F., Wainwright, W.S. *Innovative Traffic Control: Technology and Practice in Europe*. FHWA, Washington, D.C., 1999.

³ Ullman, G. L., K. D. Parma, M. D. Peoples, N. D. Trout, and S. S. Tallamraju. *Visibility, Spacing, and Operation of Freeway Lane Control Signals*. Texas Transportation Institute, Sep. 1996.

surveys, while the University of Minnesota conducted extensive driver simulator experiments. While these studies will be discussed in more detail later, they provide strong evidence that the diagonal down yellow arrow indications provide improved legibility and motorist comprehension as compared to the yellow “X”. Additionally, the Federal Highway Administration (FHWA) recently approved a request made by the Virginia Department of Transportation (VDOT) to experiment with the diagonal down yellow arrow LUS on several freeways in Virginia for similar ATM applications.

The sites where Caltrans proposes to experiment with the diagonal down yellow arrow LUS are along westbound I-80 freeway in the southern section of the I-80 project corridor, which experiences high levels of congestion, annual average daily traffic (AADT) volumes of up to 270,000 vehicles, and one of the highest accident rates in the state; therefore, legibility and quick comprehension of the LUS are critical to minimize traffic turbulence, reduce perception/reaction time, and potentially reduce crashes (or collisions, as referred to by Caltrans). *CA MUTCD*

Project Description

Caltrans requests approval for experimental use of the diagonal down yellow arrow LUS indications to communicate the need for motorists to merge into an adjacent lane due to a temporary lane closure downstream. The diagonal down yellow arrow displays are proposed at eleven (11) gantry locations along the I-80 project corridor. Other proposed LUS indications include downward green arrow as well as yellow and red “X”s, which are already in compliance with the *CA MUTCD*. This request proposes to allow the use of diagonal down yellow arrow indications on LUS. These LUS are to be mounted directly above the center of freeway travel lanes on overhead gantries in the westbound direction of I-80 between Emeryville and Richmond. **Figure 2** presents a photo taken of one of the overhead gantries with LUS along I-80.

All of the LUS operations will be managed from the Caltrans District 4 traffic management center (TMC) in Oakland through the District 4 Advanced Traffic Management System (ATMS). ATMS manages each ATM strategy deployed on the I-80 project corridor. While ATMS will recommend the use of LUS and indications to display at each gantry according to roadway conditions, the TMC Operator will confirm the LUS indications prior to activation. **Table 1** presents the gantry locations.

⁴ Harder, K. A., and J. R. Bloomfield. Investigating the Effectiveness of Intelligent Lane Control Signals on Driver Behavior. 2012.

Figure 2 - Overhead Gantry with Lane Use Signs



Table 1 – I-80 LUS Experiment Locations

Location along I-80	City	Distance from upstream LUS	Number of lanes/ Number of LUS
North of Potrero Avenue	El Cerrito	-	4
South of Potrero Avenue	Richmond	2600'	4
Carlson Boulevard	Richmond	2850'	4
Central Avenue	El Cerrito	3900'	4
North of Buchanan Street	Albany	2850'	4
North of Gilman Street	Berkeley	4200'	6
South of Gilman Street	Berkeley	1750'	5
University Avenue	Berkeley	3650'	5
Between Ashby Avenue and University Avenue	Berkeley	2000'	5
Ashby Avenue	Berkeley	4600'	5
Powell Street	Emeryville	3350'	6

Public Information & Education

Caltrans has been conducting public outreach to educate the public of the components of the I-80 Smart Corridor project, including the meaning of the new LUS indications on the gantries and other ATM strategies to be deployed including Variable Advisory Speed Signs (VASS), Variable Message Signs (VMS), Information Display Boards (IDB), Adaptive Ramp Metering

Item 16-08 Request for Permission to Experiment with the Diagonal Down Yellow Arrow Lane Use Control Signal Indications on Freeways

(ARM), and Highway Advisory Radio (HAR). This has been done through a project website, local and city officials, and newspaper and television news coverage.

B. Proposed change

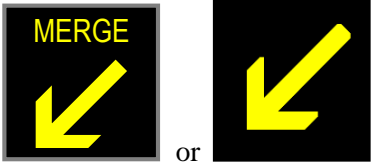
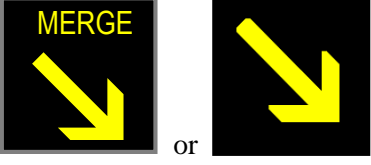
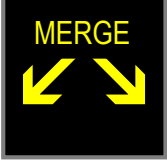
The requested experimentation is a modification to *CA MUTCD* Chapter 4M. Currently, the *CA MUTCD* allows the use of a downward green arrow indication as well as yellow and red “X”s, but does not include the use of a diagonal down yellow arrow indication. This request proposes to allow the use of diagonal down yellow arrow indications on LUS.

The diagonal down yellow arrow indication is intended to be used to communicate the need to vacate the lane (over which the LUS is shown) and merge into an adjacent lane, along with the appropriate merge direction (right or left, or either side of closed center lane) to the driver, guiding what action should be taken. This indication would generally be used upstream of a lane closure with a red “X” LUS indication. The proposed LUS are full color matrix LED signs with dimensions of 54 in. by 42 in., with the diagonal down yellow arrow indication to be displayed at full size (approximately 36 in. by 36 in.). Use of VMS and IDBs will supplement the LUS and have the ability to display lane closures.

C. Illustrations

The proposed lane use control signal indications are shown in **Table 2** below.

Table 2 - Proposed Diagonal Down Yellow Arrow Indications

Lane Use Control Signal Indications	Intended Meaning and Use Experimentation Locations
	Communicates to drivers to prepare to vacate the lane, and that a merging maneuver to the left is required
	Communicates to drivers to prepare to vacate the lane, and that a merging maneuver to the right is required
	Communicates to drivers to prepare to vacate the lane, and that a merging maneuver to the left or right is required

D. Supporting data*Existing Research*

There has been interest in using the diagonal down yellow arrow indication since the mid-1990s. A 1999 Federal Highway Administration (FHWA)-sponsored scan of European practices noted that diagonal down yellow arrows were used successfully in several European ATM deployments.⁵ One of the recommendations of that report was to reevaluate the indication for inclusion in the MUTCD.

The Texas Transportation Institute conducted a study of the diagonal down yellow arrow in 1996 that examined its legibility, driver understanding, and impact on operations.⁶ At the time, the diagonal down yellow arrow indication was being used on freeways in San Antonio, TX, while the yellow “X” indication was in use in the Dallas/Fort Worth area. Major findings of this study are summarized below:

- A closed course study used test subjects to examine the legibility distance of a diagonal down yellow arrow indication against the legibility distance of the yellow “X” indication. The researchers found that the diagonal down yellow arrow indication had longer legibility distances for older drivers—drivers older than 65 had a legibility distance of 93 percent that of 18- to 24-year-old drivers with the diagonal down yellow arrow indication. With the yellow “X” indication, older drivers’ legibility distance was only 60 percent that of younger drivers.
- A motorist survey was conducted to examine driver understanding of the two indications. On average, 3 to 4 percent more respondents rated the diagonal down yellow arrow indication as helpful, compared to the ratings of the yellow “X” indication. An interesting result of the survey was that while 12 percent of motorists who had never previously seen the diagonal down yellow arrow indication found it confusing, 31 percent of motorists who had never seen the yellow “X” indication before found that indication confusing. That means 2.5 times as many motorists found the yellow “X” indication confusing than found the diagonal down yellow arrow indication confusing. The researchers noted this lack of inherent understanding of the yellow “X” indication as a concern.
- The diagonal down yellow arrow provided no adverse effects on traffic operations compared to the yellow “X” indication. A direct before/after field study compared operational measures with the diagonal down yellow arrow indication to the yellow “X” indication under a variety of closure scenarios. The distribution of traffic approaching the lane closures and the number of lane changes were examined using field data from several sites. No statistically significant difference in the closed lane volume distributions or lane changing frequencies was found between the two indications.

⁵ Tignor, S.C., Brown, L.L., Butner, J.L., Cunard, R., Davis, S.C., Hawkins, H.G., Fischer, E.L., Kehrli, M.R., Rusch, P.F., Wainwright, W.S. *Innovative Traffic Control: Technology and Practice in Europe*. FHWA, Washington, D.C., 1999.

⁶ Ullman, G.L., K.D. Parma, M.D. Peoples, N.D. Trout, and S.S. Tallamraju. *Visibility, Spacing, and Operation of Freeway Lane Control Signals*. Report 1498-3F. Texas Transportation Institute, College Station, TX. 1996.

The University of Minnesota recently published a driving simulator study that examined the diagonal down yellow arrow indication as well as a yellow “X” indication⁷. With no other traffic on the road, drivers left the closed lane at the yellow “X” indication in only 189 out of 480 trials (39.4%). The diagonal down yellow arrow indication was found to be the most effective lane use control signal when compared directly against various combinations of a “MERGE” text and chevrons. Drivers merged to neighboring lanes at an average distance of 54 feet before the “MERGE” text only indication, 123 feet before the dynamic chevrons indication, and 266 feet before the diagonal down yellow arrow indication. This suggests that the diagonal down yellow arrow merge distance in advance of the lane closure was twice as long as the dynamic chevrons and five times longer than the distance from the “MERGE” text only indication. The researchers concluded that *“the diagonal arrow merge sign was simpler, and as a result likely took less time to process; the arrow itself was larger than the elements used for the other two merge signs making it visible when the participants were further away.”*

Given the findings of these past human factors and field studies, Caltrans believes that the diagonal down yellow arrow indication appears to provide better driver understanding of the lane use control message than the yellow “X” indication currently supported in the *CA MUTCD* and has not been shown to have any adverse effects. Given potential driver comprehension benefits over the yellow “X” indication, it is expected that the diagonal down yellow arrow indication could improve safety at the proposed experimentation sites. While no past studies have explicitly examined the use of “MERGE” text in conjunction with a diagonal down yellow arrow, it is believed that this message redundancy will further enhance the message without negatively impacting perception-reaction time.

This hypothesis is supported by a recent study that compared text signs, symbolic signs, and signs that used both text and symbols.⁸ That study found the adding text to a symbolic sign enhanced driver comprehension and reduced comprehension time, especially for unfamiliar signs. Thus, it is expected that the use of the “MERGE” text with the diagonal down yellow arrow should provide benefits beyond what has already been documented for the diagonal down yellow arrow indication since the “MERGE” text will only be added in cases where the LUS can support a full size yellow arrow. In addition to the research, the FHWA has experimentation experience with yellow arrow lane use control signal indications.

Previous Yellow Arrow Experimentations

The FHWA has previously approved seven experimentations with yellow arrow indications on LUS. Two were completed in the 1990s, two are active, and three were terminated due to lack of reporting. Caltrans has committed to completing the evaluation plan reporting. If approved, this experiment will provide the California Traffic Control Devices Committee (CTCDC) with valuable, real-world information on the effectiveness of the diagonal down yellow arrow indications to potentially adopt in a future revision of the *CA MUTCD*.

Consistency and Uniformity

The proposed experimentation sites are along the I-80 project corridor. All sites listed in **Table 1** are located in close proximity to one another and the LUS included at each gantry location are scheduled to

⁷ Harder, K.A., and J.R. Bloomfield. *Investigating the Effectiveness of Intelligent Lane Control Signals on Driver Behavior*. Report MN/RC 2012-22. University of Minnesota, 2012.

⁸ Shinar, D. and M. Vogelzang. *Comprehension of Traffic Signs with Symbolic Versus Text Displays. Transportation Research Part F: Traffic Psychology and Behaviour*, Elsevier, Vol 18, pp 72-82, 2013.

begin operation approximately at the same time. Caltrans is requesting experimentation at these sites such that motorists traveling along the entire project corridor will be presented consistent and uniform LUS indications.

Further, the proposed experimentation sites serve a large number of regional and non-local users. Caltrans' desire is to provide the most appropriate LUS indication for all road users: local and non-local. Based the lack of inherent understanding of the yellow "X" indications as found through the aforementioned research, Caltrans is requesting experimentation on using the diagonal down yellow arrow indication on LUS for the I-80 Smart Corridor sites as well as throughout the district on future projects involving freeway ATM strategies. Each LUS along the project corridor will be the same size and specifications.

E. Legally binding statement certifying the device is not patented by a patent or copyright

There are no patents or copyrights on the proposed LUS indications.

F. Time period and location of experiment

The proposed diagonal down yellow arrow indications will be deployed at the locations presented in **Table 1** above for a period of 2 years from project deployment. The anticipated deployment date of the ATM strategies of the I-80 Smart Corridor project is April/May 2016.

G. Evaluation plan

The proposed evaluation plan will examine the effectiveness of the diagonal down yellow arrow indication using several different methods. The evaluation for this experiment will be conducted by Caltrans. Quantitative measures of safety and mobility will be examined, as well as qualitative interview results from TMC operators, traffic operations engineers and motorists. Each performance measure to be examined is discussed below, and the applicability of each measure to lane closure applications are noted.

Major performance measures categories to be investigated include:

- User surveys
- LUS utilization measures
- Traffic volume measures
- Traffic speeds
- CrashData
- TMC operator, traffic operations engineers, and CHP officer observations

Since the LUS will be used to manage non-recurring events such as work zones or incidents, the ability to assess of some of these measures will be a function of whether an event occurs in close proximity to the LUS gantries and relevant detector stations. The evaluation will make use of Caltrans Performance Measurement System (PeMS) traffic data collected using inductive loops located along the project corridor on the freeway to evaluate volume and speed changes with and without use of the LUS. Thus, a subset of events where an incident or work zone occurred on the freeways in close proximity to the LUSs will be evaluated. Other events that

are not located near the loops will be excluded from the analysis since the data will not be reliable. Additional detail on the methods used for each performance measure is discussed below.

User Surveys

The evaluation for this experiment will be conducted by Caltrans and consist of user surveys to assess the effectiveness of the diagonal down yellow arrow LUS indication. Drivers of varying demographics will be polled to determine if the diagonal down yellow arrow indication is more effective in conveying the downstream lane closure and need to merge into an adjacent lane as compared to the standard yellow “X” indication currently supported by the *CA MUTCD*. Surveys will be conducted shortly after initial deployment to capture initial responses, as well as 6 months after the deployment to show whether opinions have changed as exposure to the LUS has increased.

LUS Utilization Measures

The time, duration, and location of each activation of the diagonal down yellow arrow indication will be logged by ATMS and the TMC operator. The number of times the diagonal down yellow arrow indications were activated, the number of lane-miles impacted, reason for activation, and the time duration of the activations will be used as measures of the utilization of the system. This will provide exposure metrics that could be combined with volume data or crashes to normalize the impact of the system on measures of safety or efficiency. These utilization measures will be categorized separately based on the reason why the diagonal down yellow arrow indication was used (work zone or incident). These measures will be collected throughout the duration of the study at each site.

Traffic Volume Measures

A network of loop detectors on the I-80 freeway along the I-80 project corridor will be used to examine several different performance measures in the vicinity of each gantry where the diagonal down yellow arrow indication will be displayed. Measures to be investigated include:

1. *Vehicle throughput.* The maximum throughput in the open lanes at a lane closure location, as well as before and after the diagonal down yellow arrow indication will be examined. If vehicles merge into the open lanes earlier, it should theoretically reduce turbulence at the merge point and improve freeway capacity. This “early merge” approach has been shown to have some benefits in past studies of work zone lane closures, so it will be investigated here. The throughput values observed will be compared to currently observed lane capacities on the routes. This evaluation will be limited to events that have loops located shortly after the lane closure taper.
2. *Lane utilization.* For lane closures, all vehicles have to merge to neighboring lanes after the signal. For such situations, this measure will focus on the number of lane merges before reaching the lane closure location at different distances upstream of the closure. The lane utilization values will be compared to existing lane utilization values for lane closures before implementation of the diagonal down yellow arrow indication. For both of these measures, the number of cases examined will be a function of the number of times a lane closure happens in close proximity to the LUS and appropriate detectors. The duration of the traffic volume study at each site will vary depending on the amount

of time required to generate a statistically valid number of samples. It is currently expected that this duration will be between 3 to 6 months per site.

Traffic Speeds

During lane closure applications, available loops will be used to examine speeds approaching the lane closure in each lane. This will serve as a surrogate measure for safety since high speed crashes into the end of queue are often very severe. The average speed in the closed lane, as well as the speed variance between lanes, will be examined at nearby loops before, during, and after the use of the diagonal down yellow arrow indication. Like the traffic volume study, the duration of this study will be a function of the number of uses of the diagonal down yellow arrow indication. It is currently anticipated that 3 to 6 months of data will be collected per site. The loop detector stations will also have to be located in close proximity to lane closures on the mainline.

Crash Data

Crashes that occur on freeway sections when the diagonal down yellow arrow indication is being displayed will be examined. The specific measures to be investigated include:

1. *Total Crashes.* The total number of crashes that occur after the diagonal down yellow arrow indication has been activated will be quantified. The severity and type of these crashes also will be tabulated. The total number of crashes during the display of the diagonal down yellow arrow indication will be contrasted to the number of crashes that occurred during incidents/lane closures that happened prior to the implementation of the lane control signals. Comparable lane closures and incidents will be identified in the “before” period in order to generate a fair comparison of crash exposure. Total crashes will be normalized into a crash rate based on the vehicle miles of travel that occurred during diagonal down yellow arrow activation or the comparable before period incident.
2. *Secondary Crashes.* Since the diagonal down yellow arrow indication is intended to move vehicles out of the closed lane, it may have a stronger impact on secondary crashes in the queue rather than primary crashes. Secondary crash rate will be compared between when the diagonal down yellow arrow indication is used and in the pre-installation period when a comparable incident had occurred. Existing research will be used to define a time and space threshold for defining these secondary crashes.

These metrics will be collected throughout the duration of this study. Crash data will be obtained from the Traffic Accident Surveillance and Analysis System (TASAS) or directly from CHP.

TMC Operator, Traffic Operations Field Engineers and CHP Officer Observations

The Caltrans District 4 TMC operators and traffic operations engineers along with CHP officers will be interviewed to capture their observations of driver behavior before, during, and after the diagonal down yellow arrow indications are activated. Caltrans staff continually monitor the Caltrans CCTV images across the network and visually observe conditions on site, and often carry a wealth of experience about driver behavior. These interviews will be used to identify any operational issues that occurred during the use of the diagonal down yellow arrows, as well as any difficulties in deploying the indication in certain situations.

The following considerations are important for the above analyses:

- This evaluation plan assumes that the University of Minnesota driver simulation results and the Texas Transportation Institute driver surveys described in Section D, Supporting Data

demonstrate better driver comprehension compared to the existing *CA MUTCD* indications. Caltrans does not plan to perform any additional driver simulation or comprehension testing beyond the additional user surveys.

- Traffic behavior and response to the diagonal down yellow arrow indication depends highly on the amount of traffic on the entire roadway. During congested conditions, vehicles may not be able to merge into neighboring lanes easily. Due to this, congested and uncongested (such as an off-peak incident/work zone) conditions will be analyzed separately.
- Single diagonal down yellow arrow indications and double diagonal down yellow arrow indications (indicating a left and right merge) will be evaluated separately.
- Since the I-80 experimentation sites includes several other components of ATM besides the diagonal down yellow arrow indications, isolating the individual effects of each of these traffic controls may be difficult. Results between these different sites will be contrasted to determine the range of impacts.

The evaluation reports also will include the details of the roadway geometry, locations of detectors/CCTV, metadata, and data reduction processes used.

H. Agreement to restore the site of the experiment to a condition that complies with the provisions of this Manual

Caltrans agrees to restore the experiment sites to conditions that comply with the provisions of the *CA MUTCD* under the following circumstances:

- a. Within 3 months following the end of the time period of the experiment.
- b. At any time that it determines significant safety concerns are directly or indirectly attributable to the experimentation.
- c. If requested to do so by the CTCDC or FHWA's Office of Transportation Operations.

I. Progress reports

Caltrans will provide semi-annual progress reports until the experiment is completed. A copy of the final results will be sent to the Executive Secretary of the CTCDC and FHWA's Office of Transportation Operations within 3 months following completion of experimentation.

Item 16-09 Request for Permission to Experiment with the Messages and Graphics on Dynamic Message Signs on Freeway

Recommendation: The CTCDC is requested to grant approval for Caltrans to experiment with the Messages and Graphics on Dynamic Message Signs on Freeway.

Agency Making Request/Sponsor: Caltrans/Tong, voting member

STATE OF CALIFORNIA—CALIFORNIA STATE TRANSPORTATION AGENCY

EDMOND G. BROWN JR. Governor

DEPARTMENT OF TRANSPORTATION

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*Flex your power!
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February 19, 2016

Mr. Chris Engelmann
Executive Secretary
California Traffic Control Devices Committee – MS36
P.O. Box 942874
Sacramento, CA 94274-0001

Subject: Request for Permission to Experiment with the Messages and Graphics on Dynamic Message Signs on Freeway

Dear Mr. Engelmann:

In accordance with the California Manual on Uniform Traffic Control Devices (CA MUTCD) Section 1A.10, the California Department of Transportation (Caltrans) – District 4 is requesting approval of messages with graphics on Dynamic Message Signs for experimental use on the Interstate 80 (I-80) Smart Corridor Project in San Francisco Bay Area.

The I-80 Smart Corridor Project (also known as the I-80 Integrated Corridor Mobility Project) has deployed an innovative suite of technological strategies for improving safety and mobility, proactively managing traffic congestion and incidents, and enhancing traveler information. One of the traveler information strategies is to display messages with graphics on Dynamic Message Signs to provide motorists access to enhanced real-time traveler information that would enhance the driver's knowledge of downstream traffic conditions and present information about alternate routes and travel modes.

Thank you for your consideration of this request. Caltrans is looking forward to receiving a positive response from the Committee. If you have any questions, please contact the I-80 Corridor Manager, David Man at (510) 286-4607.

Sincerely,


S. Sean Nozzari
Deputy District Director
Traffic Operations

Item 16-09 Request for Permission to Experiment with the Messages and Graphics on Dynamic Message Signs on Freeways

Background:**A. Nature of the problem**

The Interstate 80 (I-80) Smart Corridor project is located along a 20.5 mile corridor running from the interchange of I-80/I-580/I-80 in Oakland to the Carquinez Bridge in Crockett (**Figure 1**). The corridor is located within Alameda and Contra Costa Counties and includes alternative parallel arterial routes, transit services and crossing arterials that connect these facilities. The commute periods are directional with the peak morning commute in the westbound direction and evening peak in the eastbound direction; there is also considerable congestion in the off-peak direction in some locations. There is considerable weekend traffic congestion in both directions along the southern portion of the corridor within Alameda County.

As part of the I-80 Smart Corridor project in the San Francisco Bay Area, the California Department of Transportation (Caltrans), in partnership with Alameda County Transportation Commission (Alameda CTC), Contra Costa Transportation Authority (CCTA) and the local agencies along the project corridor, is preparing to deploy active traffic management (ATM) systems along the corridor to increase mobility, improve safety, enhance incident management, maximize roadway capacity, and promote environmental sustainability.

As part of this project, Caltrans is requesting consideration to display graphical images on information display boards (IDB) installed in advance of six strategic decision points along the project corridor, which experiences high levels of congestion, annual average daily traffic (AADT) volumes of up to 270,000 vehicles, and one of the highest crash rates in the state. The proposed use of graphical images would allow for additional traveler information to be displayed that would enhance the driver's knowledge of downstream traffic conditions and present information about alternate routes and travel modes, thus potentially reducing freeway congestion and crashes (or collisions, as referred to by Caltrans). Use of graphics on signs has been shown to reduce the time it takes for drivers to interpret a message. The IDBs are full-color, full-matrix LED dynamic message signs (DMS) that are mounted on overhead cantilever sign structures in portrait orientation (**Figure 2**). The dimensions of the signs are 13½-feet wide and 16½-feet tall. Caltrans intends to utilize the IDBs to display traveler information such as travel times, transit information, parking information, freeway congestion levels. Caltrans also plans to utilize the IDBs to display standard warning, guide and public safety text messages displayed on traditional dynamic message signs (DMS), such as crash information, route diversion, adverse weather conditions,

Figure 1 - Project Area



Figure 2 – Information Display Board on I-



special events, construction activity, safety messages, and AMBER alerts, and support the operations of other ATM strategies as necessary.

The *California Manual on Uniform Traffic Control Devices (CA MUTCD), 2014 Edition* supports use of DMS as documented in Chapter 2L. However, the *CA MUTCD* only discusses the use of text-based messages in alphanumeric format only. The guidance suggests use of up to three lines of 20 alphanumeric characters only, and no more than two phases in a display to convey a single message. While limiting messages to text-only may be appropriate for traditional DMS signs that have a pixel spacing of 2.75 inches, the IDBs installed for the I-80 Smart Corridor project have a pixel spacing of 0.73 inches, making them higher resolution to

clearly display graphics. Furthermore, the constraints of the guidance presented in the *CA MUTCD* limit the amount of information that can be presented to motorists, particularly when relaying downstream traffic conditions, travel times, transit times and other information that would allow motorists to make real-time route (and mode) choice decisions. The proposed use of graphical images such as graphical route information panels (GRIP) would allow for increased flexibility in providing additional traveler information in a more concise manner as compared to multiple lines of text. Graphical images would also be used to display route shields of the Interstate, US Route, and California State Route Highway System, and transit provider logos (i.e. Bay Area Rapid Transit (BART)) in lieu of text.

Caltrans bases this request to use specific graphical images displayed on IDBs on recent research and experimentation that has demonstrated the improved effectiveness of these proposed traffic control devices as compared to lines of text as currently supported in the *CA MUTCD*. Graphical images on DMS are already used in active traffic management systems in other countries, and prior studies have shown benefits in terms of driver visibility and information comprehension. The Texas Transportation Institute (TTI) carried out studies in 2008 which suggest that use of some graphical images decreased viewing times for comprehension by motorists, especially non-native-language drivers. Additionally, some graphics displaying color-coded congestion levels and crash location do not appear to result in higher information loading compared to a text-based DMS message containing the problem descriptor, location, lanes affected and effect on travel⁹. The TTI study also identified certain graphics that did not provide a benefit to drivers, and actually increased the comprehension time. Graphics such as maps of multiple routes are not proposed for this experimentation.

⁹ Ullman, B. R., N. D. Trout, and C. L. Dudek. *Use of Graphics and Symbols on Dynamic Message Signs*. Texas Transportation Institute, May 2009.

Project Description

Caltrans requests approval for experimental use of graphical images along with text messages on all IDBs installed along the project corridor. **Figure 3** and **Figure 4** presents several examples of proposed display concepts in which Caltrans is seeking approval for experimental use on IDBs along the I-80 project corridor. These graphics reflect displays that are not currently supported in the *CA MUTCD*. **Figure 3(a)** is a link-based GRIP presenting color-coded congestion levels as well as travel time to four downstream destinations. **Figure 3(b)** is a link-based GRIP presenting color-coded congestion levels along two routes to a single destination. The proposed GRIPs would be limited to displaying up to four (4) downstream destinations in a linear format. **Figure 4(a)** is presenting travel time to two distinct popular destinations with multiple route and/or mode options, displaying graphics for route shields and transit provider logos. **Figure 4(b)** is presenting transit information including transit travel times, station information, departure times, and parking availability.

Figure 3 – Potential link-based GRIPs on Information Display Boards

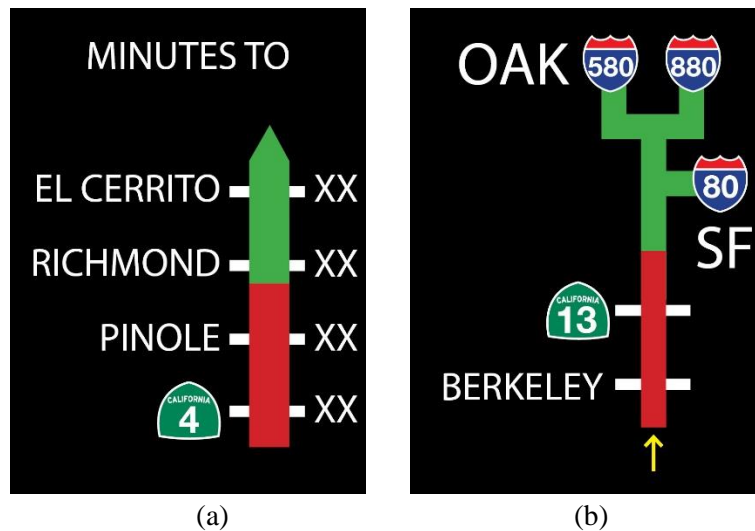
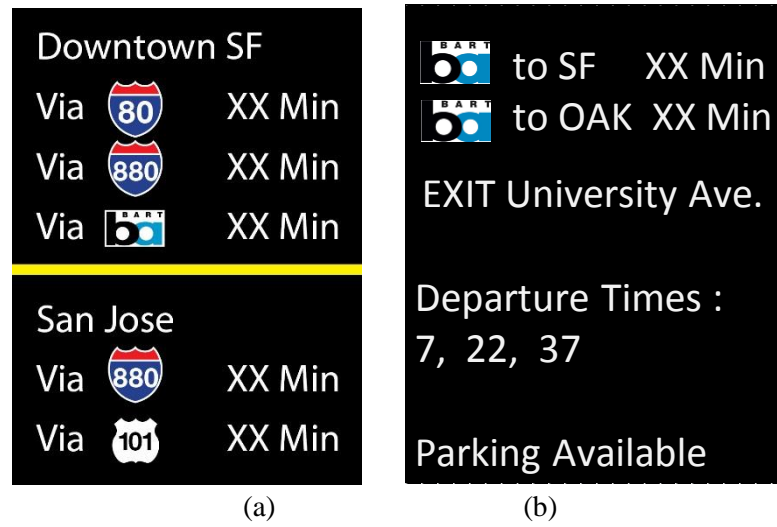


Figure 4 – Potential graphical images on Information Display Boards

The IDBs will be used to display standard warning and guide text messages such as those currently displayed on DMS. The text messages will be consistent with the format and letter heights supported by the *CA MUTCD*, with the exception of use of more than three lines of text due to portrait orientation and various font colors. The *CA MUTCD* states “if a black background is used, the color used for the legend on a changeable message sign should match the background color that would be used on a standard sign for that type of legend.”

The IDBs are installed at six locations along the I-80 project corridor (3 in each direction) in advance of strategic decision points. All of the IDB operations will be managed from the Caltrans District 4 Traffic Management Center (TMC) in Oakland through the District 4 Advanced Traffic Management System (ATMS). **Table 1** presents the IDB locations and direction, which are also illustrated in **Figure 5**.

Table 1 – I-80 IDB Experiment Locations

Location No.	Location along I-80	City	Direction
1	North of Willow Avenue	Rodeo	Westbound
2	North of Pinole Valley Road	Pinole	Eastbound
3	Between El Portal Drive and Hilltop Drive	Richmond	Eastbound
4	North of Cutting Boulevard	Richmond	Westbound
5	North of Gilman Street	Berkeley	Westbound
6	North of Powell Street	Emeryville	Eastbound

Public Information & Education

Caltrans has been conducting public outreach to educate the public of the components of the I-80 Smart Corridor project, including the potential messages that may be displayed on IDBs and other ATM strategies to be deployed including Variable Advisory Speed Signs (VASS), Variable Message Signs (VMS), Lane Use Signals (LUS), Adaptive Ramp Metering (ARM), and Highway Advisory Radio (HAR). This has been done through a project website, email notifications, newspaper and television news coverage, and through local and city officials.

Figure 5 - I-80 IDB Experiment Locations



B. Proposed change

The primary intent of the proposed use of graphical images on information display boards is to provide motorists' access to enhanced real-time traveler information so they can be prepared for freeway conditions downstream and make informed route (and mode) choice decisions in the

Item 16-09 Request for Permission to Experiment with the Messages and Graphics on Dynamic Message Signs on Freeways

most efficient and safest manner possible. The requested experimentation is a modification to *CA MUTCD* Chapter 2L to expand the use of dynamic message signs to allow for use of graphical images to be displayed on the IDBs. Currently, the *CA MUTCD* supports use of text-based messages in alphanumeric format only. The guidance suggests use of three lines of 20 alphanumeric characters and no more than two phases in a display to convey a single message. Along the California highway system, this information is typically displayed on Model 500 CMS which is limited to a single color (amber) display panel.

Due to the portrait orientation and higher resolution of the IDB, more than three lines of text could be used as shown on the examples presented in **Figure 4**. Graphical images including GRIPs displaying a link (single linear route) road network (as shown on **Figures 3(a) and 3(b)**) can be used to display real-time color-coded congestion level information in a graphical format for specific segments of the local highway network with corresponding travel times to the downstream interchanges. The proposed GRIPs would be limited to displaying up to four (4) downstream interchanges and/or destinations in a linear format. Other information to be displayed on IDBs may include travel time information to destinations for various routes (**Figure 4(a)**) and transit information (**Figure 4(b)**) using a combination of text and graphical images. Standard text messages may also be displayed with more than three lines of text and font colors consistent with the background of corresponding static sign type as recommended in the *CA MUTCD*.

Per section 2L.04 of the *CA MUTCD*, the recommended minimum letter height for changeable message signs is 18 inches where traffic speeds exceed 55 mph. However, it is recognized that newer technology signs including the full-color, full-matrix LED displays of the IDBs installed as part of the I-80 Smart Corridor project with 0.73 inch pixel pitch, offers significant improvements to legibility distance as compared to the Caltrans standard Model 500 CMS with 2.75 inch pixel pitch. The *CA MUTCD* encourages use of these advanced signs “which have the capability to display an exact duplicate of a standard sign or other sign legend using standard symbols, the Standard Alphabet and letter forms, route shields, and other typical sign legend elements with no apparent loss of resolution or recognition to the road user when compared with a static version of the same sign legend.” For text and route shields to be displayed on IDBs, Caltrans will comply with minimum recommended letter heights and route shield sizes presented in Table 2E-4 for guide signs on freeway facilities.

C. Illustrations

The proposed concepts of graphical images for use on IDBs are shown in **Figure 3** and **Figure 4**. Additionally, concepts of the link-based GRIPs are presented in **Attachment A** for all six IDB locations along the I-80 corridor. The downstream destinations displayed on each IDB will differ based on sign location and direction the sign is facing.

D. Supporting data

Use of graphical images on DMS are already being successfully deployed in Melbourne, Australia; Shanghai, China; Tokyo, Japan; Munich, Germany; France; South Korea; and the Netherlands. Japan's use of GRIPs dates back as early as 1980, while Australia and the Netherlands have deployed GRIPs with travel time information as well as the graphical congestion levels. **Figure 6** and **Figure 7** present examples of link-based GRIPs in Australia and the Netherlands.

TTI performed a study that concluded that the use of certain graphical images presenting congestion levels using green, yellow, and red in the immediate area "was interpreted well by drivers and does not appear to result in higher information loading than a text-based DMS message containing the problem descriptor, location, lanes affected and effect on travel."⁹

Figure 6 – Link-based GRIP in the Netherlands



Figure 7 – Link-based GRIP in Australia

A survey conducted in Texas in 2008 concluded that 71 percent of the polled respondents would remain on their original route when presented with travel time information displayed as text on a DMS. However, when presented with a link-based GRIP with the same travel times, the percentage of polled respondents who would likely remain on their original route dropped significantly to 48 percent. Furthermore, 90 percent of the polled respondents considered the link-based GRIP with travel times to clearly convey congestion levels as compared to the text-only DMS alternative (64 percent).¹⁰

More advanced network-based GRIPs, which display a regional roadway network map with multiple freeways or expressways with real-time congestion levels and travel time information, have been deployed internationally. The I-80 Smart Corridor is not requesting to display a network map. The Texas Department of Transportation (TxDOT) submitted an experimental request for a network-based GRIP in September 2014 which was denied by the U.S. Department of Transportation Federal Highway Administration (FHWA). The request was denied primarily due to the complexity of the proposed concept. The proposed use of graphical images on IDBs under this experimental request along the I-80 Smart Corridor will be limited to link-based GRIPs and less complex graphics.

Consistency and Uniformity

The proposed experimentation sites presented in **Table 1** are along the I-80 project corridor and are scheduled to begin operation at the same time. Caltrans is requesting experimentation at these sites such that motorists traveling along the entire project corridor will see consistent graphical images on IDBs, which are all the exact same model and size.

¹⁰ Aitken, R. J., A. J. Conway, and C. M. Walton, *Implementing Graphic Route Information Panels (GRIPs) in the United States*. Journal of the Institute of Transportation Engineers, March 2012.

E. Legally binding statement certifying the device is not patented by a patent or copyright

There are no patents or copyrights on the proposed indications.

F. Time period and location of experiment

The proposed graphical images on IDBs will be displayed at the locations presented in **Table 1** for a period of 2 years from project deployment for experimental use. The anticipated deployment date of the ATM strategies of the I-80 Smart Corridor project is April/May 2016.

G. Evaluation plan

The proposed evaluation plan will examine the effectiveness of the messages and graphical images displayed on IDBs. The evaluation for this experiment will be conducted by Caltrans. Quantitative measures of safety and mobility will be examined, as well as qualitative interview results from TMC Operators, traffic operations engineers, CHP officers and motorists.

Major performance measure categories to be investigated include:

- User surveys
- Legibility distance
- Crash data
- Speed data
- Traffic volume measures
- Transit ridership

The results of this evaluation will focus on how the use of graphics and additional information impacts traffic in the vicinity of the signs. This will be done through data evaluation as well as driver input and interviews. Each measure to be examined is discussed below.

User Surveys

The evaluation for this experiment will be conducted by Caltrans and consist of user surveys to assess the effectiveness of the various IDB display options with graphical images including the GRIPs, travel time information to destinations for various routes, transit information and other display options which may be developed. Drivers of varying demographics will be polled to determine if each of the various options are more effective in conveying traveler information as compared to standard text-based message options currently supported by the *CA MUTCD*. Surveys will be conducted shortly after initial deployment to capture initial responses, as well as 6 months after the deployment to show whether opinions have changed as exposure to the IDBs with graphical images has increased.

Legibility Distance Evaluation

An evaluation of the legibility of the IDB displays will be conducted by Caltrans to assess adequacy of the size of graphics and letter heights for various IDB options. This evaluation will consist of drivers of varying ages and demographics recording the distance upstream of IDBs in which the graphics and overall display content is deemed legible. Per the *CA MUTCD*, the recommended legibility distance for DMS is 600 feet for nighttime conditions and 800 feet for daylight conditions. This evaluation will be conducted during both nighttime and daylight conditions for all proposed IDB display options at multiple IDB locations. Letter heights and size of graphics will be adjusted if the evaluation concludes that the recommended legibility distances are not met.

Crash Data

At each of the approaches to proposed IDB locations, Caltrans will analyze crash data obtained from the Traffic Accident Surveillance and Analysis System (TASAS) or directly from CHP for before and after system activation conditions. This safety evaluation will assist in the determination of whether the IDBs are resulting in an increase in crashes which could be attributable to motorists slowing to view and comprehend the information displayed on the IDBs. The total number of crashes that occur after the IDBs have been activated will be quantified and compared with number of crashes that occurred in the same locations within a 2 year window prior to the activation of the IDBs. Analysis of the crash data will be limited to incidents that occur within 1000 feet upstream of each IDB to isolate crashes which may be attributable to the particular usage of the IDB. The severity and type of these crashes will be tabulated, along with what graphical image and/or message was displayed on the IDB downstream of the incident at the time of each crash. On a daily basis, ATMS and Caltrans' TMC Operators log what graphical image and/or message are displayed on the IDBs. These metrics will be collected throughout the 2 year duration of the study.

Speed Data

Caltrans will conduct site specific speed studies before and after system activation. This safety evaluation will assist in the determination of whether the IDBs are resulting in a decrease in vehicle speeds which could be attributable to motorists slowing to view and comprehend the information displayed on the IDBs. A statistically relevant sample size of speed observations will be collected in the vicinity of each IDB under free flow conditions, when congestion levels have no effect on travel speeds. Speed profile observations will be collected when each IDB is in use. Caltrans will log what graphical image and/or message was displayed on each IDB at the time of the spot speed observation. The "after deployment" spot speed study will be conducted for each of the IDB display options in the experimentation. Speed profiles will be developed for before and after system activation conditions and compared to assess differences in vehicle speeds as a result of messages being displayed on IDBs.

Traffic Volume Measures

This evaluation will make use of Caltrans Performance Measurement System (PeMS) traffic data collected using loop detectors located along the project corridor. A network of loop detectors on the freeway mainline and ramps will be used to collect traffic volume data before and after system activation. Traffic volumes for off-ramps downstream of IDBs displaying heavy congestion conditions ahead will be analyzed and compared with average off-ramp volumes during the same sample baseline period (i.e. weekday peak hour) to assist in the determination of the effectiveness of the IDBs. Increased off-ramp volumes would suggest an increase in diverted trips which can be attributable to the real-time traveler information displayed on IDBs. Traffic volumes will be analyzed before and after system activation at one or more off-ramps. The duration of the traffic volume study will vary depending on the amount of time required to generate a statistically valid number of samples.

Transit Ridership

For the IDB options displaying graphical images with transit information, Caltrans will analyze BART ridership data to evaluate its effectiveness in promoting shifts in mode choice; it is anticipated that presenting real-time transit information including transit travel times, station information, departure times, and station parking availability will result in a proportion of drivers deciding to complete their trip using BART, particularly during the peak commute times. Available BART ridership data will be collected for the Richmond-Millbrae and Richmond-Fremont lines for boardings at the Richmond, El Cerrito Del Norte, El Cerrito Plaza, and North Berkeley stations. The peak commute period ridership before and after system activation will be compared and analyzed to determine the effectiveness of the IDBs with transit information.

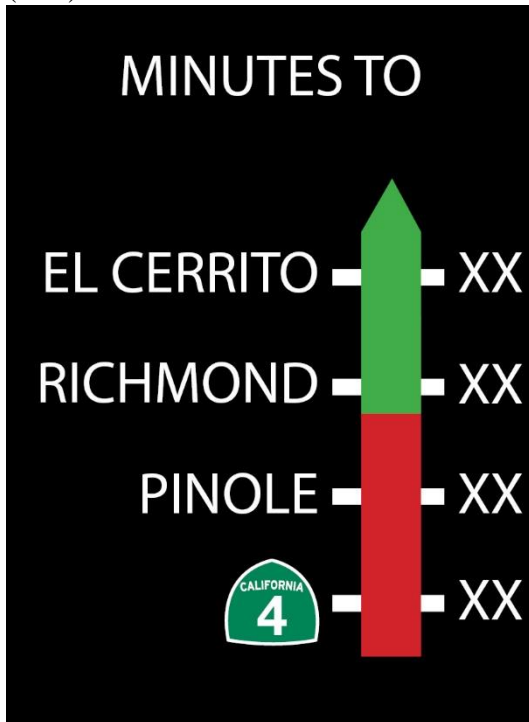
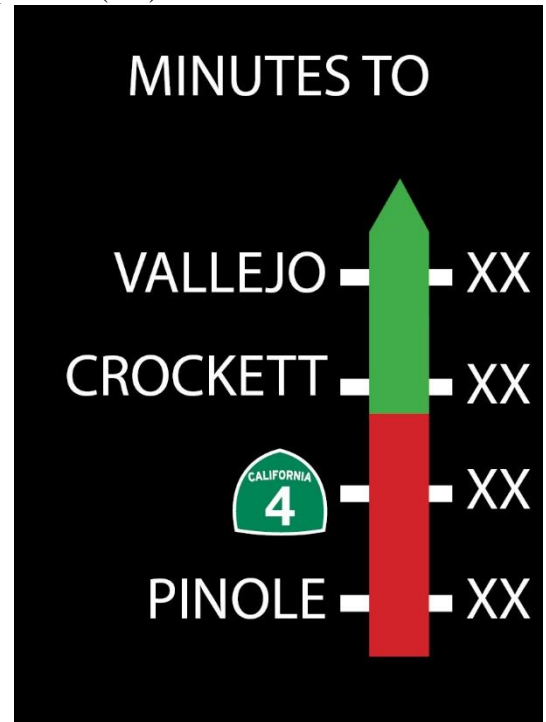
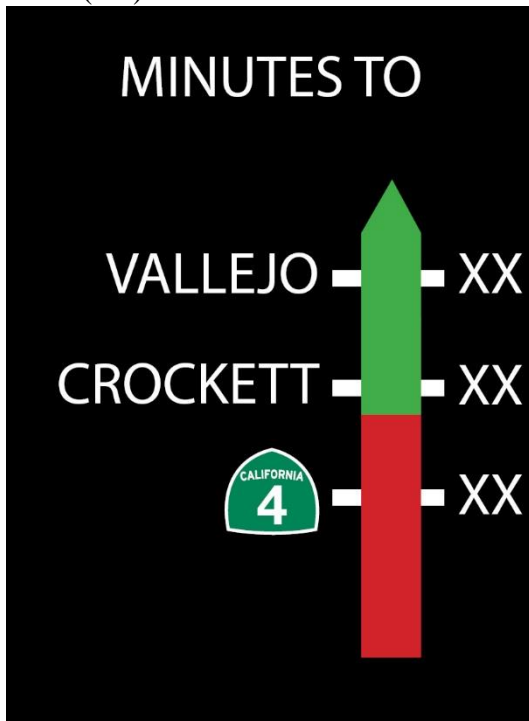
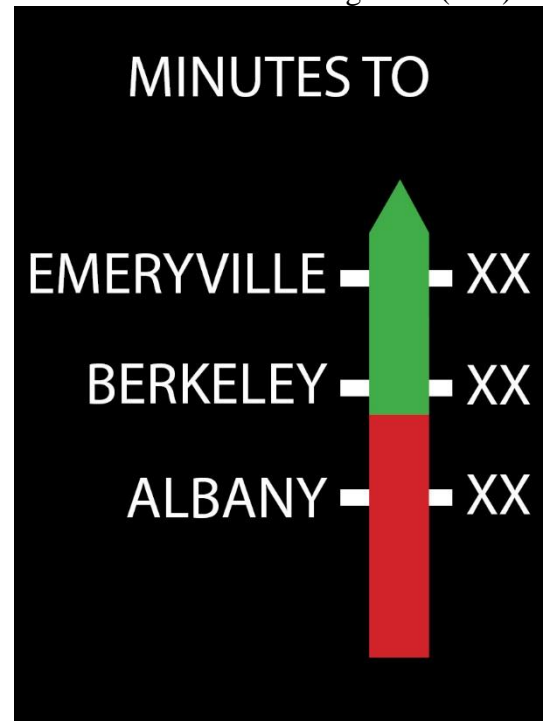
- H. The evaluation reports also will include the details of the roadway geometry, locations of detectors, metadata, and data reduction processes used. Agreement to restore the site of the experiment to a condition that complies with the provisions of this Manual

Caltrans agrees to restore the experiment sites to conditions that comply with the provisions of the *CA MUTCD*, which includes use of standard text-based messages only, under the following circumstances:

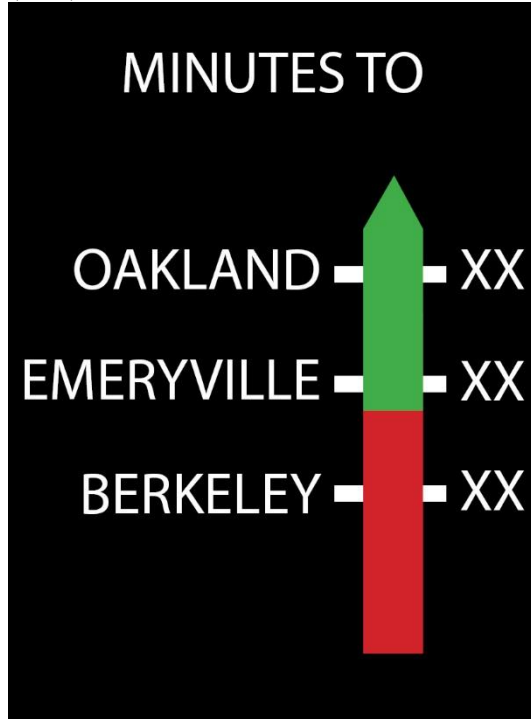
- a. Within 3 months following the end of the time period of the experiment.
- b. At any time that it determines significant safety concerns are directly or indirectly attributable to the experimentation.
- c. If requested to do so by the CTCDC or FHWA's Office of Transportation Operations.

- I. Progress reports

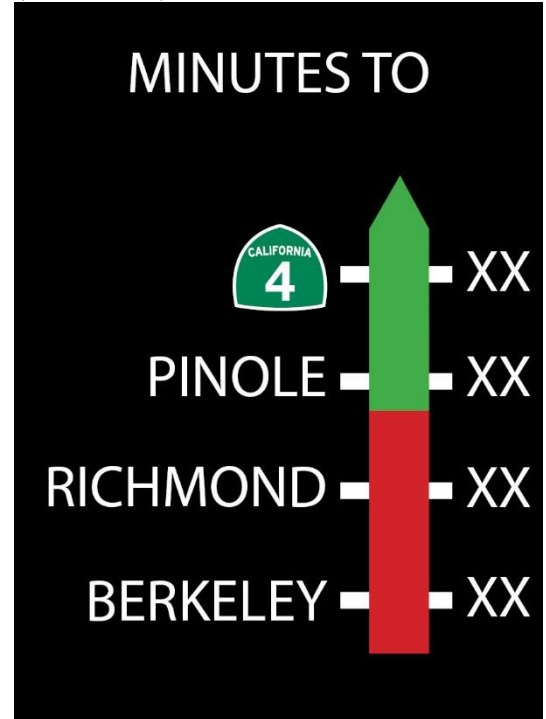
Caltrans will provide semi-annual progress reports until the experiment is completed. A copy of the final results will be sent to the Executive Secretary of the CTCDC and FHWA's Office of Transportation Operations within 3 months following completion of experimentation.

**ATTACHMENT A – LINK-BASED
GRIP EXAMPLES****Location 1:** North of Willow Avenue
(WB)**Location 3:** Between El Portal Drive and
Hilltop Drive (EB)**Location 2:** North of Pinole Valley
Road (EB)**Location 4:** North of Cutting Blvd (WB)

Location 5: North of Gilman Street
(WB)



Location 6: North of Powell Street
(Eastbound)



Item 16-10 Request for Permission to Experiment with Wrong-Way Retroreflective Pavement Markers for Ramp Edgelines and Ramp Directional Arrows Type II, III, and V

Recommendation: The CTCDC is requested to grant approval for Caltrans to experiment with the use of retroreflective pavement markers on ramp edgelines and directional pavement arrows.

Agency Making Request/Sponsor: Caltrans/Tong, voting member

Background:

The California Department of Transportation, District 11- San Diego requests permission to conduct an experiment using **TYPE C (Clear/Red) or Type H (Blank/Red) Reflective Markings on Type II, Type III and Type V ramp pavement arrows.** As a non-standard traffic control device to determine their effectiveness in improving wrong way driver encroachments on the State freeway system. A modified Standard Detail A24 (A/B) is attached for reference. In addition it is requested to use **TYPE H (Blank/Red) Reflective Pavement Markings** with a Detail 27B white edge line stripe on ramps in a pattern as outlined on the attached Wrong Way Ramp Delineation schematic. The Department already places TYPE (Y/R) Reflective Markers on the left edge line Detail 25 and TYPE C (Clear/Red) on Freeway mainlines near ramps.

The request is part of a Wrong Way Pilot project being implemented in District 3 and District 11 over the course of the next 6-8 months. Florida DOT, Texas DOT and Pennsylvania DOT have all begun experimenting with these types of retroreflective markers with pavement arrow markings on ramps and have shown a 38-54% reduction in Wrong Way movements based solely on just adding the reflective markers to pavement arrows on ramps.

1. PROBLEM STATEMENT

Caltrans District 11 – San Diego has had 13 fatal Wrong Way driver collisions since January 1, 2015, more than two times the average yearly rate for the District and about half of what the total statewide rate is for a yearly period.

2. PROPOSED SOLUTION

District 11 proposes a pilot project on State Route 15 (SR-15) starting at Postmile (PM) M4.54 through Interstate 15 (I-15) ending at PM M30.85. This segment of the Route 15 corridor was chosen based on a review of the last five Wrong Way Monitoring Report (WWMR) Table A Collision Locations. Two areas of this route were in the WWMR for 2009, 2011 and 2013 (latest one currently available). For SR-15, at the southern area of this segment, Postmile (PM) M5.63 to PM R6.02 was in the 2011 and 2013 WWMRs. For I-15, at the northern area, PM 26.18 to PM M27.01, PM 26.18 to PM M27.17 and PM M25.85 to PM M26.86 were in the WWMR for 2009, 2011 and 2013, respectively.

Item 16-10 Request for Permission to Experiment with Wrong-Way Retroreflective Pavement Markers for Ramp Edgelines and Ramp Directional Arrows Type II, III, and V

Based on a review of Regular Ramps (R) and Direct Access Ramps (DAR)(X) between PM M4.54 and PM R30.85, it was concluded that two groupings would be proposed for enhancements. Group 1 ramps are those that are approximately within 5 miles of the wrong way incident segments of the WWMR's and Group 2 are the ramps in between the two WWMR segments (and the ramps in Group 1). Therefore, one to three enhancements are provided for every ramp between PM M4.54 and PM R30.85 on Route 15.

The following are the proposed enhancements:

Enhancements "A", "B" and "C" are proposed for the R and X exit ramps on the Route 15 corridor. They "build" on each other - with all 60 R and X ramps from Group 1 and 2 (34 and 26, respectively) receiving Enhancement "A", 17 of the 34 from Group 1 also receiving Enhancement "B", and 9 of the those 17 also receiving Enhancement "C".

Enhancement "A" is a replacement on the exit ramp of all the one-way retro-reflective pavement markers to a two-way type with red on the backside. This simple and relatively inexpensive enhancement to "red alert" a wrong way motorist is appropriate for all the exit ramp locations. Refreshing or installing a Detail 41 left edge line guideline is also included, where applicable, with this enhancement.

Enhancement "B" is the installation of rows of one and two-way retro-reflective pavement markers with a red on the backside in a closely-spaced pattern near the end of the exit ramp. It is recommended at all the X exit ramps because they are shorter in length and often one lane, thereby providing less opportunity for marker replacement by the "A" enhancement. The "B" enhancement is also recommended for several of the more complicated R exit ramps (like those with a transit facility or an adjacent entrance ramp) located within the WWMR investigation areas in the Group 1 list.

Enhancement "C" is the installation of a signing with blinking LED-bordered wrong way signs and with TMC/CHP dispatch notification and camera verification of a wrong way driver. This is recommended for the four transit facility exit ramps at the R1 and R2 locations and all five of the X1, X4 and X5 location DAR exit ramps. These nine Group 1 locations are shorter ramps with possibly more confusing intersections at city streets, and known or suspected wrong way locations.

In addition, a minimum of 4 and up to 60 ramps will have the ramp arrows modified with the addition of Type (C/R) retro reflective pavement markers.

3. PROPOSED OBJECTIVE

The objective of the experiment will be to determine the usage and effectiveness of additional retro reflective pavement markings on ramp directional arrows Type II, III and V to reduce the incidence of wrong way encroachments on the freeway system.

4. EXPERIMENT SCHEDULE

- Propose Pilot Project to HQ September 2015-December 2015
(Pilot Project concurred by HQ)

Item 16-10 Request for Permission to Experiment with Wrong-Way Retroreflective Pavement Markers for Ramp Edgelines and Ramp Directional Arrows Type II, III, and V

- Installation of retro reflective markers June - July 2016
- Experimental Period July 2016 – December 2017
- Evaluation and Results June 2017 and January 2018

WORK PLAN

Installation

The **WRONG WAY REROREFLECTIVE PAVEMENT MARKERS ON RAMP EDGELINES AND DIRECTIONAL PAVEMENT ARROWS** will be installed under several projects that have already received funding approval from the Department's Director as an integral part of the existing Wrong Way packages already installed on freeway ramps. All existing, conventional Wrong Way sign and marking packages will remain in place and this request to experiment will only supplement already existing conventional wrong way signing and pavement markings.

Evaluation

Effectiveness and acceptance will be measured via monitoring equipment being placed at several ramps by Caltrans Division of Research, Innovation and System Information who will be conducting the research component of the Wrong Way Pilot project.

In addition, information obtained from District 11 Traffic Management Center of Wrong Way notifications and incidents along with I-15 corridor will be compared with data from years. There are currently hundreds of reported wrong way driver incidents along the I-15 corridor each year with many never resulting in location of the wrong way driver or an incident.

EVALUATION PROCEDURES

Caltrans District 11 requests that the Committee approve the preliminary evaluation plan outlined below. Other criteria and procedures may evolve during the evaluation period. These additional ways of evaluating the use of wrong way retro reflective pavement markers on edge lines and ramp directional arrows and any changes in procedures added to the assessment criteria will be discussed in the scheduled reports submitted to the project sponsor and the Committee.

- 1) Installation Plans and Specifications– to be prepared by Caltrans District 11.
- 2) Maintenance Recording – to be performed throughout the life of the experimentation period.
A separate maintenance log sheet will be created for each site. Periodic inspections will be performed and logged by Caltrans District 11.

- 3) Wrong Way Accident data will be monitored and analyzed by Caltrans District 11 and the California Highway Patrol as well as the Division of Division of Research, Innovation and System Information.
- 4) Observations will be conducted to determine the effectiveness of the pilot project. Ramps will be equipped with video and digitized photo equipment to help document the behavior of any wrong way driver for reporting to the Committee, Caltrans, and the Legislature or other interested public agencies.

Measures of effectiveness and acceptance during the before and after the testing period may include, but are not limited to, the following actions:

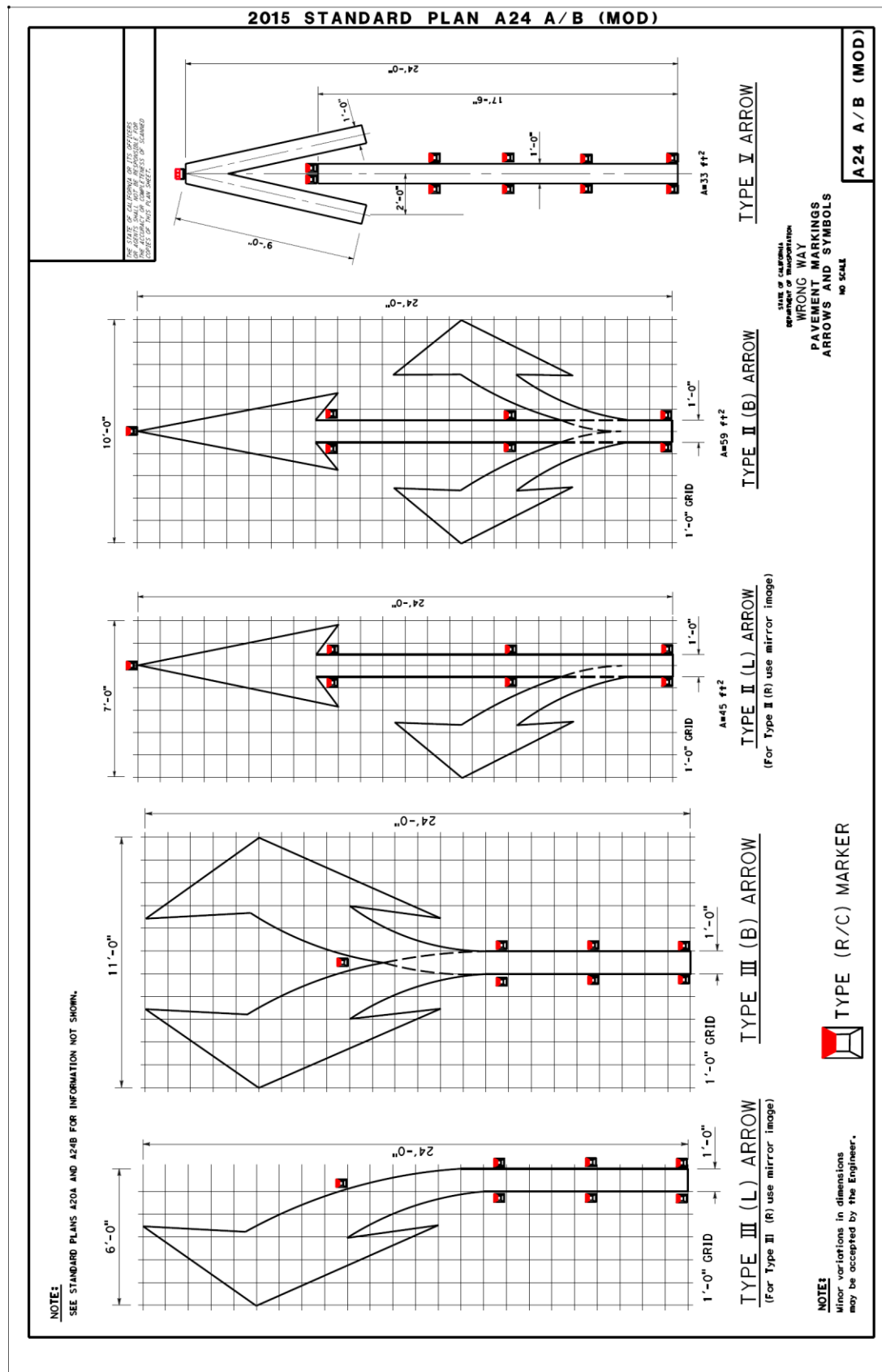
- Compare the total number of wrong way incidents reported to the District Traffic Management Center during the experimental period compared to a before time period of the same.
- Evaluate correction of wrong way drivers via video detection units being implemented by placing equipment at a number of ramps to assess self-correction of driver.

ADMINISTRATION

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INFORMATION FROM TEXAS DOT
COUNTERMEASURES FOR WRONG-WAY MOVEMENT ON FREEWAYS:
OVERVIEW OF PROJECT ACTIVITIES AND FINDINGS
REPORT: FHWA/TX-04/4128-1



Figure 17. WRONG WAY GO BACK Message on Electronic Sign in Australia.

Red-Backed Pavement Markers

Red reflective raised pavement markers are another widely used countermeasure. These RPMs are used as a countermeasure on freeway main lanes and also by some agencies on exit ramps, either along the edge lines and/or as part of the wrong-way pavement arrow. Type II-R is the common RPM placed on freeway main lanes with the red side facing in the wrong-way direction. Type I-R is the common RPM placed on edge lines and in wrong-way pavement arrows. [Figure 18](#) provides a picture of a typical wrong-way RPM.

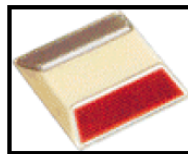


Figure 18. Typical Wrong-Way Raised Pavement Marker.

Wrong-Way Pavement Arrows

Wrong-way pavement arrows are another traditional countermeasure for discouraging wrong-way entry onto restricted facilities. The MUTCD provides the following advice on the use of wrong-way pavement arrows (see [Figure 19](#)) ([19](#)):

- *Standard:*
Where through traffic lanes approaching an intersection become mandatory turn lanes, lane-use arrow markings shall be used and shall be accompanied by standard signs. Lane use, lane reduction, and wrong-way arrow markings shall be designed as shown in [Figure 19](#).
- *Guidance:*
Where crossroad channelization or ramp geometrics do not make wrong-way movements difficult, a lane-use arrow should be placed in each lane of an exit ramp near the crossroad terminal where it will be clearly visible to a potential wrong-way road user.
- *Option:*
The wrong-way arrow markings may be placed near the downstream terminus of a ramp to indicate the correct direction of traffic flow and to discourage drivers from traveling in the wrong direction.

TxDOT has a slightly different standard wrong-way pavement arrow than what is contained in the national MUTCD (22). Figure 20 provides the detailed drawing for the standard TxDOT wrong-way arrow that is slightly longer and wider than the national standard.

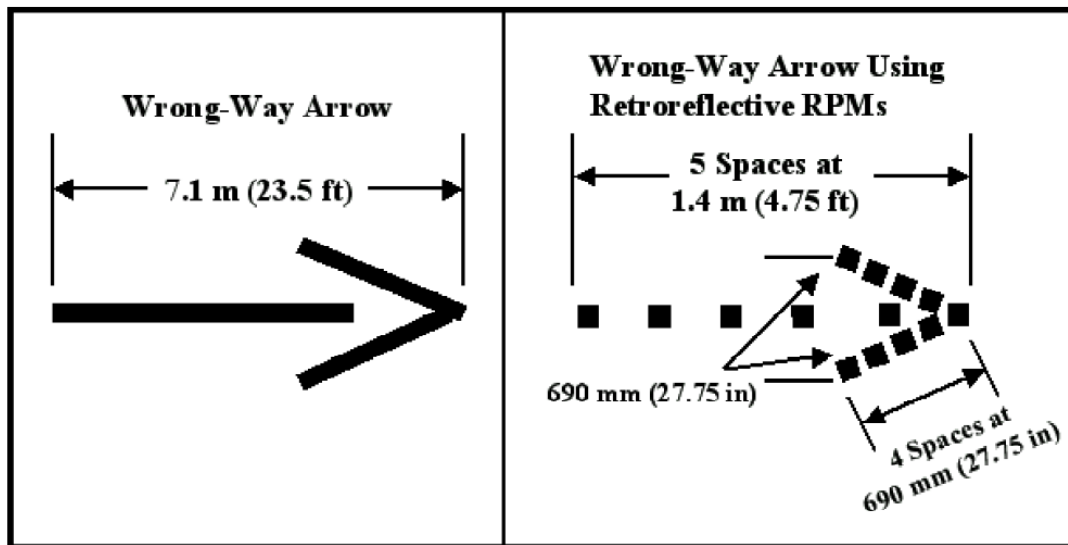


Figure 19. Wrong-Way Pavement Arrow Details Found in Figure 3B-20 of the MUTCD.

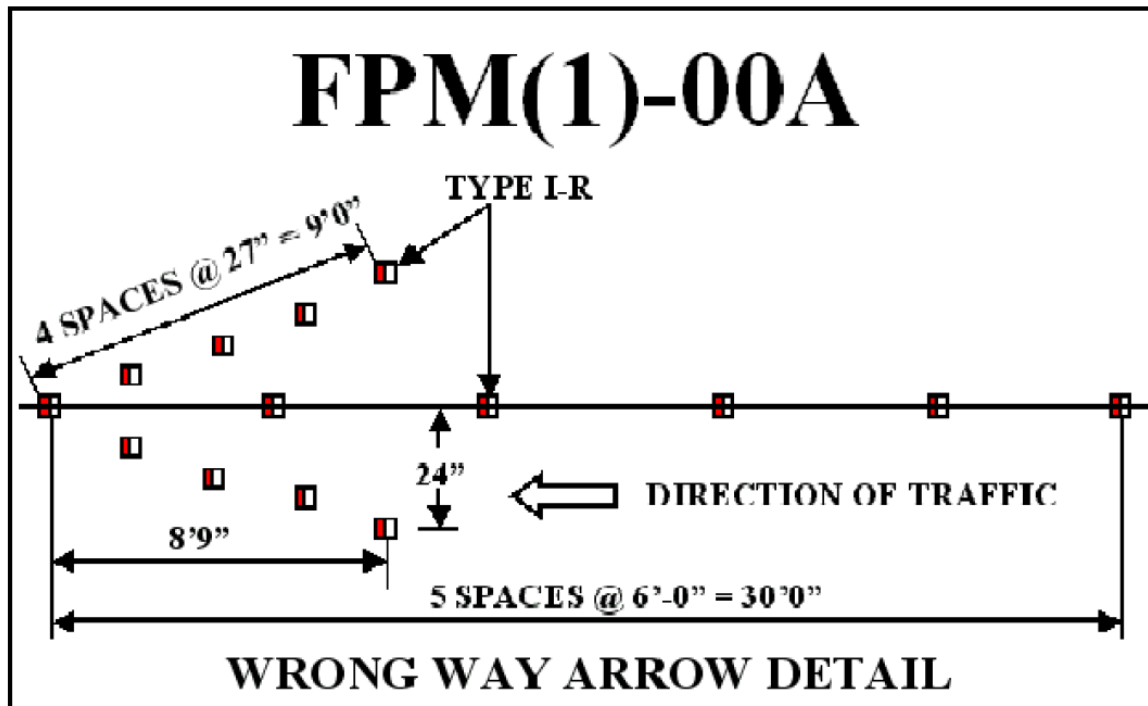


Figure 20. TxDOT Wrong-Way Pavement Arrow Detail (22).

8. Discussion Items:

None

9. Tabled Items**Agenda Item 15-15 Proposal for striping a space for bicycle use at locations with right-turn-only lanes**

Agency Making Request/Sponsor: Caltrans/ Duper Tong, voting member

Background:

Per the Highway Design Manual Section 403.6, locations with right-turn-only lanes should provide a minimum 4-foot width for bicycle use between the right-turn and through lane when bikes are permitted. The Caltrans Division of Design has suggested that striping guidance be provided in the CA-MUTCD to reflect the advisory standard mentioned above.

Update:

Caltrans is in the process of developing figures for this topic and will present these at a future meeting.

9. Next Meeting

June 30, 2016

City of San Carlos

10. Adjourn